COMPOSITION, ANALYSIS AND DIVERSION ALTERNATIVES OF THE SOLID WASTE STREAM AT MEMORIAL UNIVERSITY, ST. JOHN'S, NEWFOUNDLAND

RIVENDELL K. BONGARD

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by

Rivendell K. Bongard

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Abstract

This report was developed on the initiative of the Waterford Hospital Foundation to integrate an Ever Green Recycling depot in cooperation with Memorial University of Newfoundland (MUN). A three week solid waste audit was performed on the St. John's campus to determine the current waste composition and generation rates. The methods presently employed for managing the solid waste stream and the amount of compostable and recyclable materials presently landfilled were identified. Public awareness and attitudes towards recycling on campus were also surveyed.

Memorial University generates 3,500 short tons of solid waste per annum (2.03 lb/capita·day) and does not have a comprehensive solid waste management policy. According to the audit results and the Newfoundland recycling regulations, recyclable materials (office paper, newspaper, corrugated cardboard, plastics, Tetra Pak, glass, tin and aluminum cans) constitute 29.86% and compostable matter (food and yard wastes) represents 11.79% of MUN's solid waste stream.

Furthermore, this study attempts to identify procedures for waste reduction and the recovery of recyclable and compostable materials. Appropriate waste management could reduce the present waste collection expenditures of $110,000 per annum for the main campus by 42% to $64,000. Cooperation with the WHF could transform the recyclable waste into a minimum revenue of $42,000 annually. Also, approximately 460 short tons of waste could be diverted into compost to condition local topsoil.

Acknowledgements

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The help of the following individuals at Memorial University are acknowledged gratefully: Dr. Leonard M. Lye, Faculty of Engineering and Applied Science, for his input and for an invaluable reference on conducting public questionnaires; Geraldine Kennedy, Safety and Environmental Services, who provided essential information and contacts within University Works; Gary G. Bradshaw, P. Eng., M.B.A., Director of University Works, for his authorization to proceed with the solid waste audit; Clifton Chaytor, Manager of Grounds Management, for providing solid waste collection schedules; Albert Morgan, Facilities Management, for the background information on the waste collection system; Judith A. Power, Project Design and Drafting, who supplied

blueprints of the Memorial University Campus Site Plan; Sharon Vere-Holloway, Facilities Management, who provided financial information concerning the waste collection services; Jane Holwell, Office of Registrar, for student enrollment data; Connie Wall, Human Resources, for 1997 MUN employment values; Klaus Gries, Laboratory Manager, Faculty of Engineering and Applied Science, for supplying a workplace to perform the solid waste audit.

In addition, the assistance of the following individuals is greatly appreciated: Sandy Smith, Industrial, Commercial and Institutional Coordinator, Centre and South Hastings Recycling Board, for practical advice on the implementation and operation of recycling facilities; June B. Gorrell, Reg.N., Trenton Memorial Hospital, for supplying occupational health information; John T. Drover, P. Eng., Waste Manager, Department of Environment and Labour, Government of Newfoundland and Labrador, for provincial recycling regulations; Liz King, Nova Services, for beverage vending machines data.

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List of Abbreviations and Symbols Used

CSU	Council of the Students' Union
ft^2	square feet
HSC	Health Sciences Centre
MRR	materials recovery rate
MSW	municipal solid waste
MUN	Memorial University of Newfoundland
NewBRI	Newfoundland Beverage Recovery Inc.
R	revenue lost per annum
R_f	revenue lost during the fall term
R_{ss}	revenue lost during the spring/summer term
R_w	revenue lost during the winter term
TSC	Thomson Student Centre
WHF	Waterford Hospital Foundation
yd^3	cubic yards

Chapter I: Background Information

"In early times, the disposal of human and other wastes did not pose a significant problem, for the population was small and the amount of land available for the assimilation of wastes was large" (Tchobanoglous, Theisen and Vigil, 1993). Today, modern societies generate significant amounts of waste, all directly related to our "civilized" ways of life. As the amount of solid waste continues to increase, we are forced to explore other options for its storing, collecting, reducing and recycling.

This study was developed on the Waterford Hospital Foundation initiative to integrate the Ever Green Recycling programme with Memorial University of Newfoundland efforts to reduce solid waste entering local landfill sites. It addresses the current waste composition and generation rates at MUN (Chapter II - Solid Waste Audit). The methods presently employed for managing the solid waste stream and the amount of compostable and recyclable materials presently landfilled are identified.

The study also examines public awareness and attitudes towards recycling (Chapter III - Public Opinion Poll at MUN). It attempts to identify procedures for waste reduction and recovery of recyclable materials (Chapter V - Conclusions) and researches the feasibility of implementing an Ever Green depot on campus (Chapter IV - Projected Materials Recovery Rates and Financial Values).

1.1 Objectives of the Study

The objectives of this project are:

- to determine the solid waste generation rates at Memorial University
- to determine the composition of MUN's solid waste stream
- to determine the amount of recyclable materials in MUN's solid waste stream
- to determine the amount of compostable materials in MUN's solid waste stream
- to determine the participation rate if a recycling depot was created on the main campus
- to determine the level of public awareness concerning recycling, items considered recyclable and methods of waste disposal
- to project the recovery rate of recyclable materials
- to project the revenue generated by implementing a recycling depot on campus
- to identify procedures for waste reduction and to minimize waste collection costs
- to provide alternatives for the recovery of recyclable and compostable materials

1.2 Waterford Hospital Foundation

The Waterford Hospital Foundation was founded in 1993 in St. John's, Newfoundland, to support mental health programmes and to address the stigma associated with mental illness. The programme is committed to (WHF information sheet):

- providing services and opportunities for people who use the Waterford Hospital and other psychiatric services across the province;
- increasing public awareness of mental health issues.

The community based therapy programmes accomplish three goals:

- people with mental illness earn money and require less social assistance. It also helps them stay out of expensive hospital beds.
- they learn new skills and increase their self-esteem and confidence. Top quality products are made and sold to support patients from all over Newfoundland and Labrador.
- the more people see and use WHF services, the less stigma is attached to mental illness.

The Foundation has various programmes that provide employment opportunities for people in the mental health system. One such example is St. John's based Mill Lane Enterprises. It is one of the most progressive and successful long-term treatments in Canada where over 35 people manufacture a range of woodwork, textile and clerical products (see Appendix A for the WHF financial report).

Ever Green Recycling, a joint project of Mill Lane Enterprises and WHF, is a residential and commercial recycling programme, one of the most cost-effective in Canada. It operates three depots in St. John's: at the Regatta Plaza Building, 92 Elizabeth Avenue, at Mill Lane Enterprises, 807 Water Street, and at Cowan Avenue at Waterford Bridge Road, which employ over 60 people who sort recyclable materials and process beverage container refunds. Ever Green depots accept beverage containers (aluminum cans - including beer, glass and plastic bottles, mini sips, steel cans, gable tops and tetra boxes - all refunded $0.03 per item), wine and liquor bottles or cartons (refunded $0.10 per item), and nonrefundable grades 1 and 2 plastics and newspapers. Beer bottles must be returned for refund at local beer retail outlets. According to the WHF information sheet, their recent efforts have encouraged new groups to establish their own recycling depots.

In 1996 Mill Lane Enterprises and Ever Green Recycling were awarded Canadian Mental Health Association Work & Well-being Award and St. John's Clean and Beautiful Environment Award (WHF, 1997).

The Waterford Hospital Foundation believes that there is an outstanding opportunity to create a recycling depot on the campus of Memorial University. WHF would like to create a cooperative arrangement with MUN's administration to set up such a depot. In this case, WHF would provide financial and human resources, transportation, marketing and promotions, necessary operational permits and expertise in depot management. The main requirement is 3,000 ft^2 on campus for sorting purposes.

1.3 Memorial University of Newfoundland

Memorial University of Newfoundland is the only university in Newfoundland and Labrador. It has campuses in St. John's and Corner Brook, as well as in Harlow, England, and St. Pierre et Miquelon. It was established in 1925 as Memorial University College as a memorial to Newfoundlanders who lost their lives during World War I. On August 13, 1949, the College obtained full status as a university.

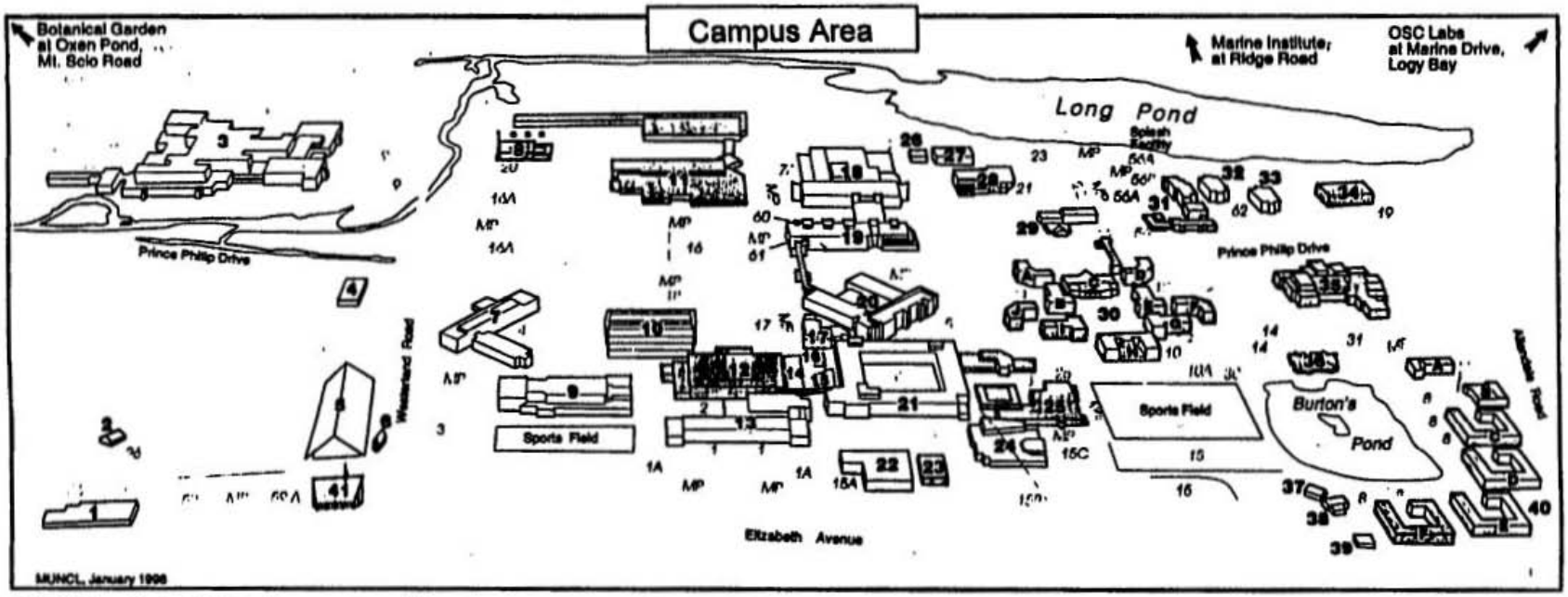
The objectives of Memorial University of Newfoundland are (MUN Calendar 1996-97):

- to develop an institution of higher learning deserving of respect for the quality of its academic standards and of its research;
- to establish new programmes to meet the expanding needs of the province;
- to provide the means whereby the University may reach out to all the people.

The scope of this study focuses only on the main Memorial University campus in St. John's which covers a total area of approximately 220 acres with the Arts and Administration, Science, Chemistry-Physics, G.A.Hickman, Henrietta Harvey, Physical Education, Biotechnology, Services, M.O.Morgan, Health Sciences, S.J.Carew, Alexander Murray, Faculty of Business Administration, and the Captain Robert A.Bartlett buildings, the Queen Elizabeth II Library, Paton College, Burton's Pond Apartments, Council of Student Union - MUN Child Care Centre, the Thomson Student Centre, St. John's

College, Coughlan College, Queen's College and a number of smaller buildings (see Figure 1.1).

Figure 1.1 - Memorial University Campus Map



1 **Helge & Anne Stine Ingstad Building (I)**
Printing Plant

2 **Alumni House (LL)**

3 **Health Sciences Centre (H)**
Faculty of Medicine
School of Nursing
School of Pharmacy

4 **CBC Television**

5 **Aquarena**

6 **Westerland Road Building**
Campaign Planning Group

7 **Education Building (E)**
Cafeteria
Continuing Studies
Educational Technology
Faculty of Education
Folklore
Folklore and Language Archive

8 **Utilities Annex**

9 **Physical Education Building (G)**
School of Physical Education and Athletics

10 **Queen Elizabeth II Library (L)**
Bookstore
Centre for Newfoundland Studies
CNS Archives

11 **NRC - Institute for Marine Dynamics**

12 **Thomson Student Centre (T)**
Banking Machine
Breezeway Bar
CamerasMUN
Campus Ministries
Conlace
Council of the Students' Union
Counselling Centre
Employment Services Centre
Food Court
General Student Services
Glenn Roy Blundon Centre
Information/Copy Centre
Post Office
Scholarships Office
Government Student Aid
Travel Agency
Women's Resource Centre

13 **Arts and Administration Building (A)**
Anthropology
Banking Machine
Cafeteria
Classics
Comptroller/Cashier's Office
Economics
English
Faculty of Arts
History
Insurance Agency
Philosophy
President's Office
Printing Services
Registrar's Office
Religious Studies
Robert G. Reid III Theatre
Sociology
Student Affairs and Services
University Relations
Vice-Presidents' Offices

14 **Psychology Annex (PA)**
Writing Centre

15 **Computing Services (CS)**

16 **Student Health Centre (SH)**

17 **Biotechnology Building (BT)**
Small Animal Care

18 **Engineering Building (EN)**
Cafeteria
Computer Science
Co-operative Education
Faculty of Engineering and Applied Science
Ocean Engineering Research Centre (OERC)

19 **Earth Sciences Building (ER)**
Centre for Earth Resources Research (CERR)
Earth Sciences
School of Graduate Studies

20 **Chemistry-Physics Building (C)**
Cafeteria
Chemistry
Faculty of Science
Physics and Physical Oceanography

21 **Science Building (SN)**
Academic Advising Centre
Biochemistry
Biology
French and Spanish
Geography
German and Russian
Linguistics
Political Science
Psychology
Women's Studies

22 **Mathematics Building (HH)**
Computing and Communications
Maritime History Archive
Maritime Studies Research Unit
Mathematics and Statistics

23 **Facilities Management Storage**

24 **Music Building (MU)**
Donald F. Cook Recital Hall
School of Music

25 **Facilities Management Building (BV)**
Campus Enforcement and Patrol (Security)
Continuing Studies (PPD)
Facilities Management
Institute for Social and Economic Research (ISER)
School of Continuing Education
University Relations (Photography)

26 **Centrifuge Centre (CF)**

27 **Capt. Robert A. Bartlett Building (K)**
Centre for Cold Oceans Resources Engineering (C-CORE)

28 **Business Administration Building (B)**
Faculty of Business Administration

29 **St. John's College**
Chapel
School of Social Work

30 **Paton College Residences:**
A Rothermere
B Barnes
C R. Gushue Hall
D Bowater
E Burke
F Squibs
G Curtis
H Hatcher
I Blackall
J Doyle
Student Housing Office

31 **Coughlan College**
Student Employment Centre

32 **Spencer Hall**
Office of Research
Seabright Corporation

33 **Field Hall**
Bitters Pub
Graduate Students' Union

34 **Queen's College (Q)**
Archaeology Unit
Centre for Material Culture Studies

35 **St. John's Arts and Culture Centre**
Art Gallery of Newfoundland & Labrador

36 **Child Care Centre (CC)**

37 **Math Learning Centre**

38 **Ocean Sciences Centre Office**

39 **Eco-Research (ISER)**

40 **Burton's Pond Apartments:**
A Baltimore
B Corte Real
C Cabot
D Cartier
E Gilbert
F Guy

41 **St. Augustine's Anglican Church**

*(Building - room number prefixes)

P Parking Area+
MP Metered Parking

+All numbered parking areas are restricted to permit holders only.

1.4 Provincial Solid Waste Regulations

In Newfoundland, the Department of Environment and Labour is responsible for the regulation of solid waste disposal. The legislation is based on The Waste Material Disposal Act which was promulgated in 1973 and amended in 1976 to streamline and clarify its provisions. The document states: "21. (1) The Lieutenant-Governor in Council may make regulations

(d) respecting the location, design and standard of construction, maintenance and use of waste disposal sites and the use and operation of waste management systems or part of a waste management system;

(e) designating waste materials by class, description or otherwise, and regulating or restricting the dumping of waste material in waste disposal sites either completely or by reference to the designation."

Currently, there are approximately 240 waste disposal sites in the province serving approximately 95 percent of the residents with generally three technologies used. There are 166 landfill sites which are not designed in accordance with engineering principles. Waste management on site is often not carried out within the acceptable regulations. Another technique, used at 52 sites, is the incineration of waste. Finally, six "sanitary" landfilling sites are designed and operated somewhat in accordance with standard and accepted practices for a waste disposal site (Dominie, 1992).

Although the provincial government recognizes less than desirable conditions at many disposal sites, a comprehensive strategy for waste management is still yet to be developed. Overall, there is very little information available on individual sites and on the quantity and quality of waste generated and disposed of in Newfoundland. Most of the time, no effort is made to dispose of waste in separate areas on waste disposal sites. Wastes are intermixed and disposed as a commingled unit (Dominie, 1992).

So far, very little effort was made to recycle waste material on a community basis. Only one community, Steady Brook, has implemented a "blue box" programme. Some communities provide support for individuals collecting materials normally accepted by Nova Recycling, the only recycling company in Newfoundland. Other localities have developed contracts with salvage firms to have car wrecks removed from their waste stream.

On January 15, 1997, the provincial government launched the Green Back Trash to Cash Program for beverage containers, developed under the Beverage Container Control Regulations (promulgated under the Packing Materials Act). This programme is basically a deposit-refund system for beverage containers. Consumers pay a deposit at the point of purchase and receive a refund when the empty container is returned to a Green Depot. This initiative is to reduce litter, add to provincial recycling efforts and to create jobs.

A Multi-material Stewardship Board is responsible for implementing the system. Initially, the Multi-material Stewardship Board was to focus on administering the deposit-refund system for beverage containers. In time, the board is to develop

programmes to divert other wastes from landfills such as used tires, batteries and various consumer packaging.

Under the new deposit-refund system, aluminum/metal cans, glass beverage or liquor bottles, plastic beverage or liquor bottles and drink/juice boxes are redeemable for refund at licensed depots located throughout the province. Milk containers and infant formula are excluded from the system at this time.

The price of ready-to-serve beverage containers includes a deposit of 6 cents. Of this amount, 3 cents is refunded to the consumer when the container is returned to a depot, 2.5 cents are provided to depot operators for every container collected and 0.5 cents goes towards supporting the system. Whereas, wine and liquor containers require a 20 cent deposit, 10 cents of which is returned to the consumer. The deposit-refund system on beverage containers is managed by a not-for-profit corporation Newfoundland Beverage Recovery Inc. (NewBRI).

The goal is to divert 80% of the beverage containers from landfills by 2001. It has been estimated that there are 172 million beverage containers disposed of in Newfoundland annually. As of May 6, 1997, there were 36 green depots in full operation throughout the province, employing more than 100 people. Sixteen million beverage containers have been returned for recycling. One hundred and sixty tractor trailer loads of empty beverage containers and other materials have been shipped to various locations in Atlantic Canada and the United States to be processed for recycling. At this rate, the programme will meet the first year goal of a 50 per cent recovery rate in beverage

containers. Where only last year, most of these products ended up at landfills (Department of Environment and Labour, 1997).

1.5 Memorial University Regulations

The University does not have a comprehensive solid waste management policy despite the fact that, as expected, it generates considerable amounts of trash - approximately 3,500 short tons or 100,000 cubic yards of solid waste per year (excluding waste from the Health Sciences Centre and off campus locations; see Chapter II, Section 2.3). It takes time and more than one study to fully understand all the sources, amounts and types of solid waste generated by MUN. Nevertheless, this project reports the results of a solid waste audit which was completed on campus during the month of July, 1997, as an attempt to understand what exactly leaves the University in terms of trash and is dumped at local landfill sites.

In St. John's there are two solid waste contractors - Browning Ferris Industries (BFI) and Newfound Disposal Systems Limited. MUN has a local contract with the latter. The contract is signed for three years with an option of renewal every 12 months. It covers servicing 33 campus dumpsters with the distinction of two separate areas: main campus area and Health Sciences Centre area. The transportation cost for collecting and

hauling waste from campus to the landfill site and landfill tipping fees are already calculated in the contract; there are no separate charges. Unlike before when the fee was based on the waste tonnage, for the 1997-98 season the collection charges are based on the number of pickups. The cost of a regular lift is approximately $10 (calculated as monthly rates for each site) and $30 for an extra lift. Overall, for waste collection services MUN expended (Department of Facilities Management, MUN):

- in 1995-96 → $76,844 (main campus) and $44,169 (Health Sciences Centre)
- in 1996-97 → $99,100 (main campus) and $45,500 (HSC)
- in 1997-98 → $110,000 (committed for main campus) and $60,000 (HSC).

University Works employees indicated a few problems they have been encountering while working with Newfound Disposal Systems Limited. For example, contracted truck drivers do not follow the pick-up schedule provided by the University. Such irregularity leads to extra pick-ups and unnecessary waste collection expenses. Inaccurate invoicing also causes waste management predicaments and prevents the preparation of precise statistics.

Recognizing the need to protect the environment by reducing the amount of solid waste entering landfill sites, MUN has attempted to introduce the concept of recycling on campus. However, due to various reasons, present recycling efforts are highly limited.

The current system is based on recycling bins distributed unevenly on campus. Small blue containers were purchased in 1993 from a federal grant of $20,000 which was part of the Environmental Partners Fund between the federal government and The

Memorial University Recycling Committee. These containers were placed in some offices. Recycling is at the discretion of the office occupant.

Furthermore, blue and grey containers are located in the Thomson Student Centre cafeteria. Five are designated for pop cans, three for glass bottles, two for plastic bottles and one is for paper. Similar containers can be found in the S.J.Carew Building. Sporadic "paper recycling centres" are located across campus.

Light green and white collection containers for white paper, flattened cardboard and beverage cans are located at Thomson Student Centre, G.A.Hickman Building, Chemistry-Physics Building, Queen Elizabeth II Library, Ingstad printing facility, S.J.Carew Building, Science Building, Child Care Centre, Paton College Residences and Ocean Sciences Centre (see the Memorial University Campus Site Plan in Appendix B).

Nova Recycling limits the number of collection containers they are willing to service. According to the verbal agreement, Nova is to come on campus every Tuesday to empty the containers. But Nova employees have been highly irregular. Furthermore, when collections have occurred, recyclables that were intermixed, contaminated, partially crushed or containing cardboard were left behind. Transportation costs for the collection of refundable materials at MUN is absorbed by Nova Recycling. It should be noted that Memorial University has never received the 3 cent refund that it is entitled to. Nova officials argues that it is necessary to cover the cost of transportation (Safety and Environmental Services, MUN).

Chapter II: Solid Waste Stream Audit

A waste audit is one of the first steps in implementing a recycling programme. Determining the percentage of refundable beverage containers entering Memorial University's waste stream is one of the facts that must be ascertained. A solid waste audit is one of the fastest methods of discovering this value.

Furthermore, a solid waste audit provides a blueprint regarding present waste management practices. It defines the type, quantity and origin of solid wastes generated. It also demonstrates the effectiveness of existing management policy and procedures affecting waste generation and the equipment and systems required.

A solid waste audit also assists in identifying waste reduction methods. It provides avenues to reduce wasteful practices by implementing proper waste management systems while lowering operating costs. Moreover, it establishes a waste record for future researchers. Preliminary scientific data will be beneficial for individuals performing a full-blown waste audit. In Ontario Bill 143 (The Waste Management Act) was passed in 1993. By law institutions like universities must perform waste audits and develop waste reduction work plans (Recycling Council of Ontario, 1997).

In the near future, similar regulations may be passed in Newfoundland because many of the existing landfills (e.g. Robin Hood) are nearing permanent closure. Memorial University has the opportunity to remain ahead of the future legislation by incorporating

all available data into a badly needed integrated solid waste management policy and procedures.

2.1 Audit Methodology

All forms of authorization were received before beginning any phase of the solid waste audit. A number of photographs were taken during the audit phase of the study (consult Appendix F).

2.1.1 Obtaining Previous Waste Audit Information

The first step in the process of an audit is to research all sources of data related to former audits performed. Because there are no records of previous solid waste audits at Memorial University, recyclable materials recovered and returned for revenue or rates of waste diversion, this step was not possible.

2.1.2 Determining Audit Duration and Sampling Locations

Due to time and financial restrictions it was necessary to restrict the length of the solid waste audit to two weeks.

A map of the locations of the 34 dumpsters containing solid wastes generated by MUN does not exist. This is understandable because their locations and size vary with semesters and waste collection plans.

The Manager of Grounds Management provided two schedules that Memorial University uses for the present waste collection plan (see Tables 2.1 and 2.2); Schedule "A" (Table 2.1) is valid for the fall and winter terms (September 1 - April 30) and Schedule "B" (Table 2.2) is valid for the spring/summer term (May 1 - August 31). All but one of the collection container locations agree with the information stated in Schedule "B" (published on March 20, 1997). The only discrepancy was the number of containers at the chemistry building. The number of 6 cubic yard containers was increased from one to two. For the remainder of this report, unless specified otherwise, Schedule "B" will be quoted.

The solid waste assessment took place on the main campus of Memorial University of Newfoundland, St. John's, Newfoundland. Off campus locations (Vivarium, Food Pilot Building and M.S.R.L.) and the Health Sciences Centre (including Medical School) were excluded from the sampling programme - the latter was rejected from the study because of the health risk posed to the author (see the sampling locations on the Memorial University Campus Site Plan at the back of the report; consult Appendix B for the legend).

Furthermore, even though the St. John's Arts and Culture Centre, Aquarena and NRC-Institute for Marine Dynamics are located within the parameter of MUN and have waste containers on the university grounds, all three have independent contracts for the collection of their wastes. Each building was then disregarded from the sampling programme.

It was also decided that two 8 cubic yards containers at the Engineering Building should be excluded from the study because of their size. These containers were too big to enter and exit safely without proper equipment being available.

Table 2.1

Schedule "A"

Fall and Winter

March 20, 1997

Specification for Removal of Garbage for Memorial University of Newfoundland

Building	Size of Containers Cubic Yards	Number of Containers	Total No. of Lifts Per Week Sept. 1-April 30	Scheduled Time of Lift	Monthly Rates ($)	Extra Lift Rate ($)
Science Building	2 @ 6	2	10 M-T-W-T-F	7:00 a.m. 1:00 p.m.		
Chemistry Building	6	1	5 M-T-W-T-F	7:00 a.m.		
*Main Dining Hall (1 east - 1 west)	6	2	26 M-T-W-T-F-S-S	7:00 a.m. & 1:00 p.m.		
Hatcher House	6	2	14 M-T-W-T-F-S-S	7:00 a.m. & 1:00 p.m.		
*Thomson Centre	6	2	26 M-T-W-T-F-S-S	7:00 a.m. & 1:00 p.m.		
Arts and Administration	6	1	10 M-T-W-T-F	7:00 a.m. 1:00 p.m.		
Arts and Education	6	1	10 M-T-W-T-F	7:00 a.m. 1:00 p.m.		
Baltimore	6	1	3 M-W-F	1:00 p.m.		
Cabot	6	1	3 M-W-F	1:00 p.m.		
Cartier	6	1	3 M-W-F	1:00 p.m.		
Gilbert	6	1	3 M-W-F	1:00 p.m.		
Guy	6	1	3 M-W-F	1:00 p.m.		

Schedule "A"

Specification for Removal of Garbage for Memorial University of Newfoundland

Building	Size of Containers Cubic Yards	Number of Containers	Total No. of Lifts Per Week Sept. 1-April 30	Scheduled Time of Lift	Monthly Rates ($)	Extra Lift Rate ($)
Henrietta Harvey Building	6	1	1 W	7:00 a.m.		
Medical School	4	1	3 M-W-F	7:00 a.m.		
Alumni House	Hand Pick-up	0	3 M-W-F	-		
Curtis & Squires	4	1	3 M-W-F	1:00 p.m.		
Doyle and Blackall	6	1	3 M-W-F	1:00 p.m.		
Rothermere and Barnes	6	1	3 M-W-F	1:00 p.m.		
St. John's College	6	1	1 W	7:00 a.m.		
Queen's College	6	1	2 Tue-F	7:00 a.m.		
Coughlan College & Spencer	6	1	4 M-W-F-S	7:00 a.m.		
Utilities Annex	2	1	1 F	7:00 a.m.		
Engineering Building	2 @ 8	2	12 M-T-W-T-F-S	7:00 a.m.		

Table 2.1

Schedule "A"

Specification for Removal of Garbage for Memorial University of Newfoundland

Building	Size of Containers Cubic Yards	Number of Containers	Total No. of Lifts Per Week Sept. 1-April 30	Scheduled Time of Lift	Monthly Rates ($)	Extra Lift Rate ($)
Vivarium	6	1	2 Tue-F	7:00 a.m.		
Incinerator	2	1	1 F	7:00 a.m.		
Health Sciences Centre	25	1	6	-		
Daycare Centre	4	1	3 M-W-F	7:00 a.m.		
Food Pilot Building	4	1	1 F	7:00 a.m.		
Services Building	6	1	2 Tue-F	7:00 a.m.		
QEII Library	6	1	4 M-W-F-S	7:00 a.m.		
Ingstad Building	6	1	3 M-W-F			
M.S.R.L.	6	1	3 M-W-F	7:00 a.m.		
Health Science Centre Container Cardboard	32	1	6 M-T-W-T-F-S			

Table 2.2

Schedule "B"

Summer
May, June, July & August
March 20, 1997

Specification for Removal of Garbage for Memorial University of Newfoundland

Building	Size of Containers Cubic Yards	Number of Containers	Total No. of Lifts Per Week May 1-August 3	Scheduled Time of Lift	Monthly Rates ($)	Extra Lift Rate ($)
Science Building	2 @ 6	2	6 M-W-F	7:00 a.m.		
Chemistry Building	6	1	5 M-T-W-T-F	7:00 a.m.		
*Main Dining Hall (1 east - 1 west)	6	2	26 M-T-W-T-F-S-S	7:00 a.m. & 1:00 p.m.		
Hatcher House	6	2	14 M-T-W-T-F-S	7:00 a.m. & 1:00 p.m.		
*Thomson Centre	6	2	26 M-T-W-T-F-S-S	7:00 a.m. & 1:00 p.m.		
Arts and Administration	6	1	10 M-T-W-T-F	7:00 a.m. 1:00 p.m.		
Arts and Education	6	1	5 M-T-W-T-F	7:00 a.m.		
Baltimore	6	1	3 M-W-F	1:00 p.m.		
Cabot	6	1	3 M-W-F	1:00 p.m.		
Cartier	6	1	3 M-W-F	1:00 p.m.		
Gilbert	6	1	3 M-W-F	1:00 p.m.		
Guy	6	1	3 M-W-F	1:00 p.m.		

Table 2.2

Schedule "B"

Specification for Removal of Garbage for Memorial University of Newfoundland

Building	Size of Containers Cubic Yards	Number of Containers	Total No. of Lifts Per Week May 1-August 3	Scheduled Time of Lift	Monthly Rates ($)	Extra Lift Rate ($)
Henrietta Harvey Building	6	1	1 W	7:00 a.m.		
Medical School	4	1	3 M-W-F	7:00 a.m.		
Alumni House	Hand Pick-up	0	3 M-W-F	-		
Curtis & Squires	4	1	3 M-W-F	1:00 p.m.		
Doyle and Blackall	6	1	3 M-W-F	1:00 p.m.		
Rothermere and Barnes	6	1	3 M-W-F	1:00 p.m.		
St. John's College	6	1	1 W	7:00 a.m.		
Queen's College	6	1	3 M-W-F	7:00 a.m.		
Coughlan College & Spencer	6	1	4 M-W-F-S	7:00 a.m.		
Utilities Annex	2	1	1 F	7:00 a.m.		
Engineering Building	2 @ 8	2	10 M-T-W-T-F	7:00 a.m.		
Vivarium	6	1	2	7:00 a.m.		

Specification for Removal of Garbage for Memorial University of Newfoundland

Building	Size of Containers Cubic Yards	Number of Containers	Total No. of Lifts Per Week May 1-August 3	Scheduled Time of Lift	Monthly Rates ($)	Extra Lift Rate ($)
Incinerator	2	1	1 F	7:00 a.m.		
Health Sciences Centre	25	1	6	-		
Daycare Centre	4	1	3 M-W-F	7:00 a.m.		
Food Pilot Building	4	1	1 F	7:00 a.m.		
Services Building	6	1	2 Tue-F	7:00 a.m.		
QEII Library	6	1	4 M-W-F-S	7:00 a.m.		
Ingstad	6	1	3 M-W-F	7:00 a.m.		
M.S.R.L.	6	1	3 M-W-F	7:00 a.m.		
Health Science Centre Container Cardboard Recycle	32	1	6 M-T-W-T-F-S	-		

2.1.3 Identifying Waste Generation Sources

Custodial routines and routes concerning the disposal of collected waste vary (Department of University Works, MUN). The main factor preventing the waste generation sources from being precisely identified is the fact that custodians dispose of wastes in the nearest dumpster in the vicinity of the building which they are cleaning at the moment. For example, waste collected in the Chemistry Building is deposited in dumpsters other than the designated containers for the building. Therefore, most of the waste can be traced to its source, but contamination from other origins is common.

2.1.4 Determination of the Number of Waste Samples Required

Schedule "B" was the main source of information in this case concerning the total number of lifts per week for each location. Using these values and exclusion principles stated above, a total of 139 lifts per week occur during the spring/summer schedule. For each location a total number of lifts per week (the fourth column of the Schedules "A" and "B") can be observed. Therefore,

$$\%\ of\ lifts/week\ at\ location = \frac{Number\ of\ lifts/week\ at\ each\ location}{Total\ number\ of\ lifts/week\ within\ sampling\ area} \times 100$$

For example, the Thomson Student Centre has a total of 26 lifts per week. This means

that the TSC requires 19% of the total waste collection time per week.

In order to create a credible sampling programme it was decided that a total of at least 30 solid waste samples should been taken. Therefore, the percentage of lifts per week was multiplied by 30 to provide a value for the number of solid waste samples required from that specific location. Again using the TSC as an example, it was calculated that six samples should be taken at this location.

Lift percentages as low as 2% of the total waste collection time per week were considered and, after readjustment, 33 samples were used during the sampling phase of the study (see Table 2.3).

2.1.5 Scheduling

Samples were taken in accordance with scheduled times of waste pickup (Schedule "B", Table 2.2). Lift times were either 7:00 A.M. or 1:00 P.M.. Noon samples would capture a majority of the morning activities. While evening samples were taken after 7:00 P.M. to ensure that afternoon wastes would reach their maximum. As mentioned earlier, truck drivers did not follow the schedule. This led to variation in the size of samples.

Table 2.3 - Solid Waste Audit Sampling Data and Observations

Dumpster location	Percentage of lifts/week (%)	Number of samples required	Number of samples taken	Percentage of sample w.r.t. full volume capacity of dumpster(s)	
				uncompacted (%)	sub-compacted (%)
Science	4	1	1	33	20
Chemistry	4	1	1	33	18
Main Dining Hall	19	6	3 of 6	13.2	5.2
Hatcher	10	3	3	12.7	7.3
TSC	19	6	6	32	15.5
Administration	7	2	2	50	26.5
Education	4	1	1	50	24
Baltimore	2	1	1	50	21
Cabot	2	1	1	50	35
Cartier	2	1	1	67	40
Gilbert	2	1	1	67	28
Guy	2	1	1	100	49
Henrietta Harvey	1	0	0	n.a.	n.a.
Curtis&Squires	2	1	1	50	40
Doyle&Blackall	2	1	1	8	6
Rothermere&Barnes	2	1	no sample	0	0
St.John's College	1	0	0	n.a.	n.a.
Queen's College	2	1	1	25	22
Coughlan&Spencer	3	1	1	33	24
Utilities Annex	1	0	0	n.a.	n.a.
Incinerator	1	0	0	n.a.	n.a.
Day care	2	1	1	20	16
Services	1	0	0	n.a.	n.a.
QEII Library	3	1	1	100	46
Ingstad	2	1	1	33	14
Total	100	33	26		
			Average	41	23

Note: 1/ "Sub-compacted" refers to solid waste components which were separated and reduced in volume, e.g. cardboard was flattened and plastic film was compressed by hand.
2/ At Rothemere&Barnes no sample was attainable during several visitations.
3/ At the Main Dining Hall only 3 of 6 samples were attainable during several visitations.

2.1.6 Sample Collection

The Laboratory Manager of the Engineering Department provided a room where the waste composition could be determined. The room, EN 1015E, near the loading bay of the Engineering Building allowed easy access to equipment required to complete the composition analysis. The Engineering dumpster near the loading bay was used throughout the study as the only means of disposing of the waste collected to perform the manual sorting phase of the solid waste audit.

To obtain a sample for analysis, the load was first quartered. Originally, the contents of the dumpster(s) were completely taken out of the containers to determine the weight of the entire sample. This method was found to be very time consuming with the equipment available and was modified. The final method of sample "quartering" consisted of estimating the total volume of the waste in the dumpster. Then the author would enter the dumpster and choose representative garbage bags randomly from all locations within the dumpster until one quarter of the original volume was attained.

Waste samples composed of large volumes of one waste component like unbroken corrugated cardboard were noted on the individual data compilation sheets (Appendix C).

Quartered samples were placed in the trunk of the author's automobile and transported to EN 1015E. The weight of the quartered sample was then taken using the bathroom scale and uniform size clothes baskets. The difference between the author's weight and the cumulative total determined the weight of the sample.

2.1.7 Determination of Waste Composition

The next step of a waste audit is to determine the type and quantity (volume and weight) of materials in the waste stream. A total of 13 clothes baskets were used for the separation of waste into the various components (Table 2.4). Each basket was labelled as one of the components: food waste, paper, cardboard, plastics, textiles & rubber, tetra boxes, yard waste, wood, glass, tin cans, aluminum, other metals and "true" garbage (dirt, ash, highly contaminated paper products, other nonrecoverable recyclables, etc.).

Table 2.4 *Typical physical composition of residential MSW excluding recycled materials and food wastes discharged with wastewater* (Tchobanoglous, Theisen, and Vigil, 1993).

	Percent by weight			
	United States			
Component	Range	Typical	Packaging materials	Davis, California
Organic				
Food wastes	6 - 18	9.0	-	6.0
Paper	25 - 40	34.0	50 - 60	33.1
Cardboard	3 - 10	6.0		7.9
Plastics	4 - 10	7.0	12 - 16	10.7
Textiles	0 - 4	2.0	-	2.4
Rubber	0 - 2	0.5	-	2.5
Leather	0 - 2	0.5	-	0.1
Yard wastes	5 - 20	18.5	-	17.7
Wood	1 - 4	2.0	4 - 8	5.0
Inorganic				
Glass	4 - 12	8.0	20 - 30	5.8
Tin cans	2 - 8	6.0	6 - 8	3.9
Aluminum	0 - 1	0.5	2 - 4	0.4
Other metal	1 - 4	3.0	-	3.6
Dirt, ash, etc.	0 - 6	3.0	-	0.5
Total		100.0		100.0

Using a utility knife, each garbage bag was cut open to begin the manual separation of the waste. Individual items were placed in the appropriate baskets. Highly contaminated articles were considered "true" garbage. Shoes, toothpaste containers, light bulbs and disposable razors were some of the encountered articles which are manufactured using two or more materials and were also considered "true" garbage.

The moisture content (e.g. pop, rain water, etc.) of separated waste components was added to the food waste component to minimize the weight error that would occur if the liquid wastes contaminated absorbent materials like paper and cardboard.

After the sample was completely separated into the various components, the volume of each item was estimated in terms of a whole number or a fraction of a basket. These values were converted to cubic yards later in the study, knowing that a full basket represented 52.9 Litres (0.069 cubic yard; Henry and Heinke, 1996).

Once the volume of each basket was estimated, the weight of the contents was determined using the difference between the combined weight of the sampler plus the empty basket and the basket with the component. Both the volume and the weight of the various components were compared against the total volume and weight of the sample taken from the dumpster (Appendix C).

2.1.8 Disposal of Separated Waste Components

A majority of the separated waste items were dumped into the 8 cubic yards container in the Engineering loading bay as mentioned earlier. Cardboard was disposed of in the recycling bin designated for cardboard and office paper. Other recyclable materials were dropped off at the Elizabeth Avenue Ever Green recycling depot.

2.1.9 Safety and Disinfection of the Workplace

The biggest safety consideration of the project was regarded when mapping the waste containers onto the campus map discussed earlier. Waste collected from the medical building could contain biohazardous materials. Medical wastes are classified into six groups (Trenton Memorial Hospital, 1997):

1/ Pathological (e.g. human tissue)

2/ Infectious (e.g. materials containing communicable diseases)

3/ Sharps and similar (e.g. syringes)

4/ Chemical (e.g. corrosive agents)

5/ Biomedical (e.g. clothing saturated with blood products)

6/ General (e.g. kitchen and office wastes)

Sampling of medical wastes requires special training that is beyond the scope of this research project. Accordingly, the author decided to reject this building from the study.

Handling of the waste was a minor health issue considered. Safety gloves, long work pants, a long sleeved shirt, a hat and rubber boots were items that were used during the collection and handling of the solid waste.

The weather during the sampling phase was exceptionally good and the use of floor space of EN1015E was not required for sorting purposes. Sorting was performed on the loading ramp. Therefore, a final cleanup and disinfection of the sorting site was only warranted.

2.2 Data Compilation

The first step in the data compilation phase was the determination of the following percentages for each component within each sample:

$$percent\ by\ weight = \frac{weight\ of\ the\ component}{total\ weight\ of\ a\ sample} \times 100$$

$$percent\ by\ volume = \frac{estimated\ volume\ of\ the\ component}{total\ estimated\ volume\ of\ a\ sample} \times 100$$

For example, consider the TSC values in the data compilation sheet #1 (Appendix C)

Food waste $_{\text{percent by weight}}$ = 48/93.6 x 100 = 51.3%

Food waste $_{\text{percent by volume}}$ = 0.1035/0.3999 x 100 = 25.9%

The calculated percentages are tabulated in the data compilation sheets in Appendix C.

The next step was to calculate the characteristics of various waste components. The results are listed in Table 2.5.

The estimated total volume of sample was calculated first. This category was divided into two groups: uncompacted and sub-compacted waste. "Uncompacted" refers to the original volume of the sample, as found in a dumpster(s). "Sub-compacted" refers to solid waste components which were separated and reduced in volume, e.g. cardboard was flattened and plastic film was compressed by hand. The values were imported from each data compilation sheets according to the corresponding sample number and multiplied by four to obtain the value for the entire sample. It should be noted that volume and weight data contained in the compilation sheets in Appendix C refers to the quartered samples. Therefore, for further calculations the data was converted into a whole sample value (multiplied by four).

The specific weight of samples was then calculated. Again, the category was divided into two groups: uncompacted and sub-compacted waste.

$$Specific\ weight = \frac{Total\ weight\ of\ a\ sample}{Total\ volume\ of\ sample}$$

For example, consider the TSC values in the data compilation sheet #1 (Appendix C)

Specific weight $_{uncompacted}$ = 374.4 lb / 4 yds^3 = 94 lb/yds^3

Specific weight $_{sub\text{-}compacted}$ = 374.4 lb / 1.6 yds^3 = 234 lb/yds^3

This calculation was done for all samples and then averaged. The average specific weight for an uncompacted sample was 72 lb/yds^3 and for the sub-compacted sample was 128 lb/yds^3.

Percentage of sample with respect to the full volume capacity of the dumpster(s) was determined. Using the Schedule "B" (Table 2.2), full capacity of the waste locations was identified. The volume of uncompacted and sub-compacted samples was compared to the full capacity of the waste locations and then averaged. The average percentage for an uncompacted sample was 39% and for the sub-compacted sample 21%.

Table 2.5 - Characteristics of MUN's Solid Waste Stream

Sample number	Full capacity of waste location (cubic yards)	Estimated total volume of		Total weight of sample (lb)	Specific weight of		Percentage of sample volume w.r.t. full vol. capacity of waste location	
		uncompacted sample (cubic yards)	sub-compacted sample* (cubic yards)		uncompacted sample (lb/cubic yards)	sub-compacted sample* (lb/cubic yards)	uncompacted (%)	sub-compacted (%)
1	12	4	1.60	374.4	94	234	33	13
2	6	6	2.96	399.2	67	135	100	49
3	6	4	1.70	262	66	154	67	28
4	6	4	2.40	279.2	70	116	67	40
5	6	3	1.27	188	63	148	50	21
6	6	3	2.10	332.8	111	158	50	35
7	6	3	1.43	133.6	45	93	50	24
8	6	4	2.26	206	52	91	67	38
9	12	4	2.90	300.4	75	104	33	24
10	6	6	2.73	1128.4	188	413	100	46
11	6	2	0.81	104	52	128	33	14
12	4	0.8	0.62	53.2	67	86	20	16
13	6	1.5	1.31	142.8	95	109	25	22
14	6	2	0.91	82	41	90	33	15
15	12	2	1.20	86.8	43	72	17	10
16	12	4	2.13	257.6	64	121	33	18
17	12	4	2.34	238.4	60	102	33	20
18	6	2	1.41	108.4	54	77	33	24
19	12	0.5	0.39	73.2	146	188	4	3
20	4	2	1.58	144	72	91	50	40
21	12	0.5	0.39	52.3	105	134	4	3
22	6	0.5	0.34	60.8	122	179	8	6
23	12	5	2.14	224.8	45	105	42	18
24	12	6	1.80	226.8	38	126	50	15
25	12	2	1.00	88	44	88	17	8
26	12	6	1.77	140.8	23	80	50	15
27	12	3	1.50	186.4	62	124	25	13
28	12	2	1.34	86.8	43	65	17	11
29	12	2	1.53	146	73	95	17	13
AVG.	9	3	2	211	72	128	39	**21**

* "sub-compacted" refers to solid waste components which were separated and reduced in volume, e.g. cardboard was flattened and plastic film was compressed by hand

2.3 Memorial University's Solid Waste Generation Rate

Using the values from the Schedules "A" and "B" and information provided by facilities management personnel and assuming that the containers are full throughout a year (container utilization factor f = 1.0), the estimated amount of waste per week was determined for each sample location. This value was obtained by multiplying the size of a container at the location (yds^3) by the number of containers at the location and by the total number of lifts per week at the location. Then each location was totalled to calculate the overall term value. Next, the term value (yds^3/week) was multiplied by the number of weeks in the specific term. For the fall and winter terms (Schedule "A") the estimated amount of waste is 52,850 yds^3 (1,510 yds^3/week x 35 weeks). For the spring/summer term (Schedule "B") the estimated amount of waste is 23,902 yds^3 (1,406 yds^3/week x 17 weeks). Therefore, the estimated amount of waste generated by MUN in the sampling area is **76,752 yds^3/ annum**.

To calculate MUN's solid waste generation rate two values were used: the specific weight of an average uncompacted sample (Table 2.5) and the estimated annual amount of waste, calculated above. The appropriate conversion of pounds into short tons was also done.

72 lb/yds^3 x 76,752 yds^3/annum x (1 short ton / 2,000 lb) = 2,763 short tons/annum

Therefore, Memorial University solid waste generation rate for the sampling area equals **2,763 tons/annum.**

The same approach was used to estimate the generation rate for the Health Science Centre and other formerly excluded locations. Hence, for the fall and winter terms (Schedule "A") the additional estimated amount of waste is 13,685 yds^3 (391 yds^3/week x 35 weeks) and for the spring/summer term (Schedule "B") the additional estimated amount of waste is 6,647 yds^3 (391 yds^3/week x 17 weeks). And:

72 lb/yds^3 x 20,332 yds^3/annum x (1 short ton / 2,000 lb) = 732 short tons/annum

Therefore, the estimated additional amount of waste generated by formerly excluded locations equals 20,332 yds^3/annum or 732 tons/annum.

By summarizing the values for the both the sampling and the excluded areas of the main campus the author calculated the overall solid waste generation rate at MUN which is **97,083 yds^3/annum** or **3,496 tons/annum**.

2.4 Per Capita Solid Waste Generation Rate at MUN

It should be clearly stated that the generation rate per capita of solid waste at MUN is calculated with a transitory population. One can assume that faculty and staff members inhabit the main campus for approximately 8 hour per day. Whereas, the time when students can be found on campus varies greatly. During these times all three groups generate solid waste and for simplicity sake the author combined them as one. Therefore, all residents generate solid waste of an average value.

The student population was determined with the assistance of the Office of Registrar. It was found that the spring/summer enrollment is one-third of the fall or winter terms. It was assumed that the winter enrollment equals the fall enrollment. Knowing that the average enrollment for 1991 - 1996 period was 17,508 students (Memorial University Undergraduate Calendar, 1996/97), the enrollment per term can be calculated. During each of the fall and winter terms the average enrollment was 7,504 students whereas during the spring/summer term the average enrollment dropped down to 2,500 students.

The MUN Human Resources office provided 1996/97 values for the University employees (including contractual and excluding off campus personnel): 3,246 (fall), 3,846 (winter) and 3,719 (spring/summer).

Term	No. of students	No. of MUN staff	MUN population
Fall	7,504	3,246	10,750
Winter	7,504	3,846	11,350
Spring/summer	2,500	3,719	6,219
			Total = 28,319

Therefore, the weighted average for each term is 9,440 people.

Recall that the overall solid waste generation rate at MUN is 3,496 short tons per annum. First, the generation rate per day was calculated:

3,496 tons/year x 1 year/365 days x 2,000 lb/1 ton = 19,156 lb/day

Hence,

$$\textit{Generation rate per capita} = \frac{\textit{Generation rate per day}}{\textit{Weighted average of MUN population}}$$

= 19,156 lb/day / 9,440 people = **2.03 lb/capita • day**

Although in agreement with the North American values, Memorial University's present solid waste generation rate is **ten times greater** as compared to the rate for institutions in the United States in 1990 (0.21 lb/capita • day; Tchobanoglous, Theisen and Vigil, 1993).

2.5 Compostable and Recyclable Materials in MUN's Waste Stream

The next step is to determine what percentage of Memorial University's solid waste consists of compostable and recyclable materials which could be diverted. It was judged that of 13 components three were *compostable* (food waste, yard waste and wood) and six were *recyclable* (paper, cardboard, plastics, tetra boxes, glass and aluminum).

Both volume and weight are used for the measurement of solid waste quantities. Yet the use of volume as a measure of quantity can be misleading. To avoid confusion, solid waste quantities should be expressed in terms of weight (Tchobanoglous, Theisen and Vigil, 1993).

Using the data compilation sheets (Appendix C), compostables and recyclables were organized into Table 2.6. For each selected component the percentage by weight was collected from each sample and then averaged.

Compostables

- food waste - 20.8%
- yard waste - 2.7%
- wood - 0.3%

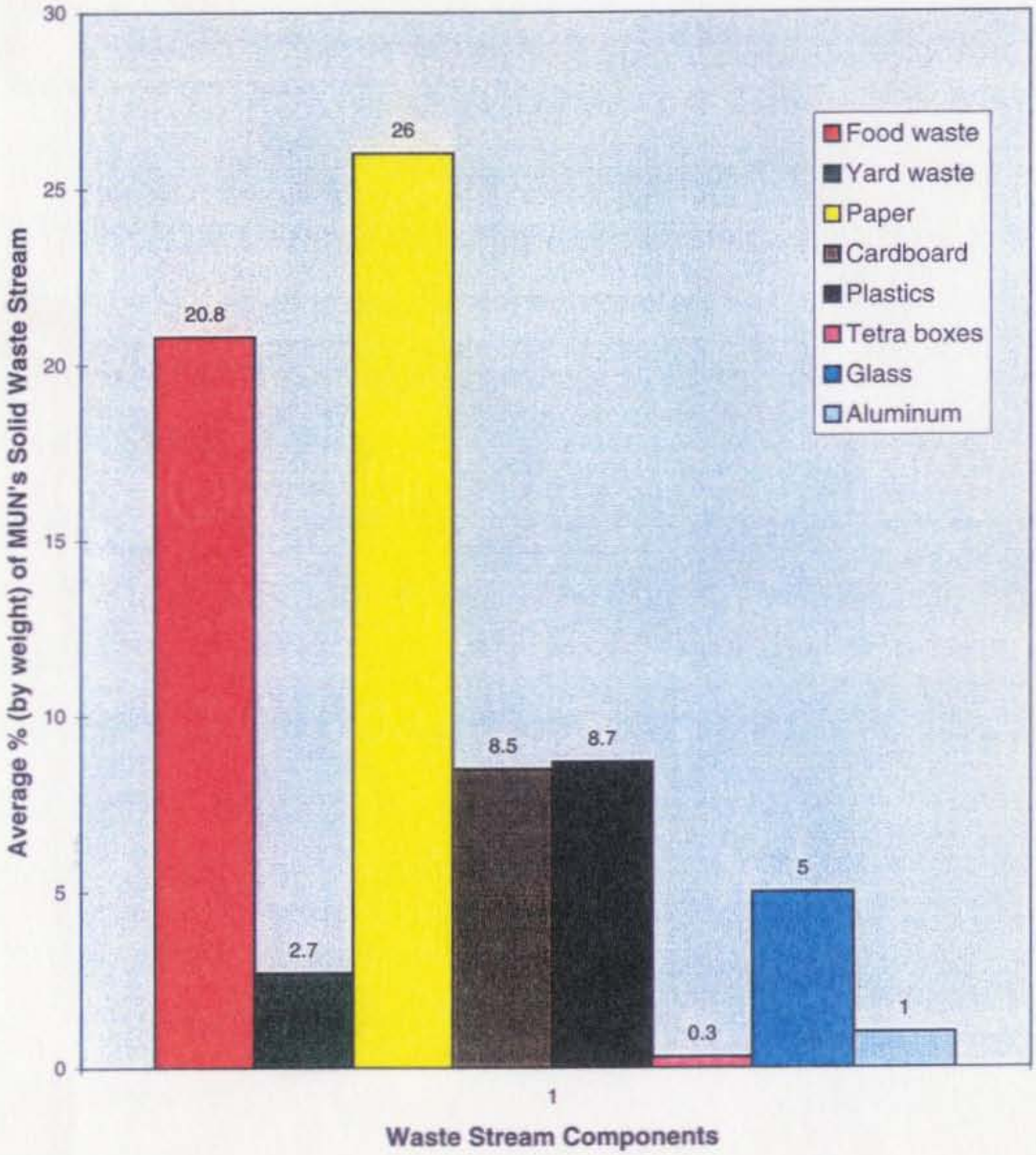
Total = 23.8%

Table 2.6 - Compostable and Recyclable Materials in MUN's Waste Stream

Sample number	Percentage of food waste in sample by weight (%)	Percentage of yard waste in sample by weight (%)	Percentage of *biodegradable* waste in sample by weight (%)	Percentage of paper in sample by weight (%)	Percentage of cardboard in sample by weight (%)	Percentage of plastics in sample by weight (%)	Percentage of tetra boxes in sample by weight (%)	Percentage of glass in sample by weight (%)	Percentage of aluminum in sample by weight (%)	Percentage of *recyclables* in sample by weight (%)
1	51.3	0	51.3	15	15	2.1	0.1	0.2	0.1	32.5
2	12	14	26	17	6	8	0.2	5	0.4	36.6
3	30.5	0	30.5	30.5	4.6	4.6	0.2	0	0.2	40.1
4	20.1	0	20.1	20.1	2.9	12.2	0.1	7.2	**7.2**	49.7
5	33	0.9	33.9	21.3	12.8	6.4	0	6.4	0.2	47.1
6	19.2	0	19.2	6	2.4	7.2	0.1	20.4	0.1	36.2
7	3	0	3	47.9	2.7	12	**3**	6	1.5	73.1
8	7.8	0	7.8	33	9.7	9.7	0.2	7.8	3.9	64.3
9	37.3	0	37.3	2.7	0.4	**21.3**	0.1	8	0.7	33.2
10	1.4	0	1.4	**91.5**	2.5	1.4	0	0.2	0.1	95.7
11	0	0	0	**96.2**	0	1.5	0	0	0	97.7
12	7.5	0	7.5	37.6	0	7.5	0	1.5	0	46.6
13	0.6	0	0.6	5.6	11.2	5.6	0	5.6	0	28
14	14.6	0	14.6	24.4	0	9.8	0.5	9.8	1.5	46
15	13.8	0	13.8	9.2	0	18.4	0.5	4.6	2.3	35
16	7.8	**40.4**	48.2	12.4	2.3	10.9	0.3	0.3	0.3	26.5
17	1.7	0	1.7	36.9	13.4	6.7	0.2	1.7	0.2	59.1
18	14.8	14.8	29.6	18.5	0.4	18.5	0.4	0.4	2.2	40.4
19	**79.2**	6.8	**86**	0.7	0.7	1.1	0.1	8.2	0.1	10.9
20	27.8	0	27.8	27.8	5.6	16.7	0.6	0.8	0.6	52.1
21	38.2	0	38.2	11.5	11.5	7.6	0.2	7.6	0.4	38.8
22	3.3	0	3.3	62.5	23	6.6	0	0.5	0.2	92.8
23	14.2	0	14.2	39.1	14.2	5.3	0.2	0.7	0.9	60.4
24	49.4	0	49.4	0.2	**28.2**	7.1	0	0	0.9	36.4
25	9.1	0	9.1	54.5	0	9.1	0.5	4.5	1.4	70
26	14.2	0	14.2	5.7	**28.4**	11.4	0.3	0	0.3	46.1
27	42.9	0	42.9	4.3	21.5	8.6	0	1.1	0.2	35.7
28	9.2	0	9.2	18.4	18.4	4.6	0.5	**36.9**	2.3	81.1
29	38.4	0	38.4	2.7	8.2	11	0.3	0.5	0.5	23.2
AVG.	20.8	2.7	*23.4*	26.0	8.5	8.7	0.3	5.0	1.0	*49.5*

Note: Bolded values denote peaks encountered during the sampling programme.

Figure 2.1 - Compostable and Recyclable Materials in MUN's Waste Stream



The above values must be modified in accordance to established composting guidelines. To produce the highest-quality compost, source-separated organic waste make the best feedstock. It should be of consistent size, free of glass, plastic, and metals and free of objectionable odours. The amount of food waste that could be diverted as compostable material is at least 50% of 20.8% (Quinte Regional Recycling, 1995).

The yard waste value remains unchanged at 2.7%. Chipping or shredding of brush and woody materials is the only requirement. Specifications for yard wastes to be composted depend on the end use of the compost (Tchobanoglous, Theisen and Vigil, 1993). Typical specifications for general-use compost produced from yard waste can be found in Appendix D.

Wood only comprises 0.3% of the solid waste stream and because this value is so small it was neglected from further analysis. But considerations for the latter are addressed in the recommendations.

Recyclables

- paper - 26%
- cardboard - 8.5%
- plastics - 8.7%
- Tetra boxes - 0.3%
- glass - 5%
- aluminum - 1%

Total = 49.5%

Not all of the materials that are recycled in other parts of Canada are presently recycled in Newfoundland. Therefore, the above values are modified to meet the present recycling guidelines.

Paper shipped to a mill must meet mill specifications regarding percentage of outthrows (grades of a lesser quality than the specified grade) and contaminants (materials detrimental to the papermaking process or that may cause damage to machinery). Examples of paper contaminants are sunburned newspaper, food containers, composites containing plastic or metal foil, waxed or treated paper, tissue or paper towels, FAX paper. Other contaminants are foreign materials such as dirt, metal, glass, food wastes, paper clips and string (Tchobanoglous, Theisen and Vigil, 1993). Paper is one of the materials that is at present being recycled on campus. Therefore, the amount of paper that could be diverted from the waste stream should be increased to a minimum of 60% of 26%.

Corrugated cardboard is the largest single source of waste paper for recycling (Tchobanoglous, Theisen and Vigil, 1993). University Works plan on removing cardboard from the waste stream completely. Therefore, the above cardboard value remains the same at 8.5%.

Established specification for plastics are extensive and beyond the scope of this report. In general, buyers require postconsumer plastic to be well sorted, reasonably free of contaminants and excess moisture (Tchobanoglous, Theisen and Vigil, 1993). Presently, in the province of Newfoundland, plastic beverage containers (numbers 1, 2, 3, 5, 6, 7)

and other number 1 and 2 plastics are recycled. Sobeys and Dominion locations also accept plastic film (number 4). Hence, the above value of 8.7% is reduced to 3.0%.

There are no literature specifications available for Tetra Pak containers. In Newfoundland this postconsumer product is recycled under the deposit-refund system. Therefore, as long as the boxes are free of external contamination, straws and are in one piece, they can be recycled. So, the above value of 0.3% is reduced only by 5%.

Glass to be used for new bottles and containers must be sorted by colour and cannot contain materials such as dirt, rocks, ceramics, high-temperature glass cookware, or other glassware (Tchobanoglous, Theisen and Vigil, 1993). The provincial requirements mention that glass beverage bottles must be whole, relatively clean and with the cap removed. Approximately 95% of the recovered glass consisted of recyclable beverage containers.

Collection centres accept all cans that are free of contamination, such as dirt and food wastes. Most community recycling centres do not accept used aluminum foil because it is usually contaminated. Large buyers accept foil if it is reasonably clean (Tchobanoglous, Theisen and Vigil, 1993). Aluminum foil constituted approximately 1% of the above value. The remaining 99% can be recycled as long as cans are in one piece and free of external contamination.

The following summary recapitulates the above comments:

Compostables

- food waste - 10.4%

- yard waste - 2.7%

Total = **13.1%**

Recyclables

- paper - 15.6%

- cardboard - 8.5%

- plastics - 3.0%

- Tetra boxes - 0.3%

- glass - 4.8%

- aluminum - 1%

Total = **33.2%**

Therefore, the total amount of recoverable materials in MUN's solid waste stream is **46.3%** (1,619 short tons/annum).

Chapter III: Public Opinion Poll at MUN

The main objective of developing and implementing a questionnaire about recycling was to determine the participation factor of the general population at the main campus of Memorial University of Newfoundland, St. John's, Newfoundland. With this data the future values of the recyclable materials recovery rate could be calculated.

Another reason for performing such a survey was to supply the Waterford Hospital Foundation and MUN with information on present attitudes and beliefs towards recycling on and off campus. Data on such questions as: Who recycles?, What items are recycled?, Are present waste reduction rates at MUN satisfactory? etc., benefit both parties. It also produces valuable input concerning the educational direction which will be required to improve the present day attitudes and beliefs towards recycling.

3.1 Survey Methodology

Survey research carries with it an obligation to follow certain ethical norms and to respect both people's privacy and the voluntary nature of their involvement. For the ethical reasons and in order to obtain honest responses, the questionnaire was anonymous

and voluntary.

A perfectly accurate survey is seldom, if ever, conducted. A survey provides accurate results when researchers minimize four kinds of error: coverage error, sampling error, measurement error and nonresponse error (Salant and Dillman, 1994). The entire main campus area was used (area probability sampling frame approach) to minimize the coverage error. Surveying at numerous locations across campus gave every member of the population fairly equal chance of being selected for the sample. The samples were obtained from the following departments: Business Administration, Education, Nursing, Philosophy, Psychology, History, Computer Sciences, Geography, English, Economics, Anthropology, Biochemistry, Statistics and Mathematics, Political Sciences, Biology, Music, Earth Sciences, Science, Physical Education, Arts, Sociology, Environmental Science, Linguistics, Engineering, Physics, Chemistry, Pharmacy, Thomson Student Centre, Comptroller's Office, Council of Student Union, Social Work, Office of Research, Oceanography, Facilities Management, Child Care, Printing Services, Accounts Payable, QEII Library, Student Housing and Food Services, Computing and Communication, School of Graduate Studies and Registrar Office.

The questionnaire was completed in one week. Face-to-Face (drop-off hybrid) survey method was used to ensure the high response rate and to minimize the rejection rate. Questionnaire sheets and pencils were handed out and then collected upon the task completion.

Sample size depends on the following characteristics (Salant and Dillman, 1994):

➛ how much sampling error can be tolerated;

➛ population size;

➛ how varied the population is with respect to the characteristics of interest.

To determine the exact number of samples the 1997 spring/summer term data was used. This data was obtained from two separate entities: MUN Human Resources provided information on full-time, part-time, contractual and student employees while the student enrollment values was attained from the Office of Registrar. For the spring/summer term of 1997 the following values apply:

- 106 custodians
- 3,613 MUN staff (excluding custodians)
- 3,725 students

Therefore the total MUN population for the spring/summer term of 1997 consists of 7,444 people.

For a population of that size and where an 80/20 split can be expected (i.e. the population is less varied - most people have a certain characteristic), the author needed a sample of 240 *completed usable* questionnaires to make estimates with a sampling error of no more than ±5% at the 95 per cent confidence level (Salant and Dillman, 1994). To minimize sampling error and to sample enough people for the required level of precision, the author decided to randomly sample 4 per cent (298 people) of the MUN population.

The quality of the sample is as important as its size. For poll purposes the MUN population was stratified into three groupings: students, custodial staff and other

university employees (professors, clerical staff, etc.). This was done in relation to their possible recycling options. According to the present recycling policy on campus students can dispose of recyclable items at scattered designated recycling containers. Whereas it is up to the office occupant to recycle or not using the provided office containers. Custodial staff has the greatest range of options: 1/ disposal in designated recycling containers, 2/ source separation of recyclables from the waste stream, 3/ disposal of recyclable materials in the departmental collection bins. Disproportionate sampling was performed to create a true picture of the whole community - 4 custodians, 145 MUN staff and 149 students.

Overall, of the surveyed population was 55% female and 40% was male. Five per cent did not answer this question. As far as the age is concerned, 7% was under 20 years of age, 33% was between 20 and 25, 13% was between 26 and 30, 15% was between 31 and 35, 7% was between 36 and 40, 7% was between 41 and 45 and 7% was over 46. Eleven per cent refused to answer this question.

Avoiding emotional and biased words is only a part of writing good questions and, therefore, of minimizing measurement error. Other issues to consider are e.g. how specific the questions should be, whether the questions would supply credible information, whether respondents are able to answer the questions and whether respondents are willing to provide the required information (Salant and Dillman, 1994).

For the interpretation reasons and to minimize measurement error, out of twelve survey questions (see Figure 3.1) seven are close-ended with ordered responses, four are

partially close-ended (in case the author overlooked an important issue) and one is open-ended. Space for additional comments was indicated. For environmental reasons the questionnaire was printed on both sides of paper. Pretesting was also conducted in order to improve the quality of the survey and included WHF feedback.

Figure 3.1 - ***RECYCLING AWARENESS QUESTIONNAIRE AT MEMORIAL UNIVERSITY***

The questionnaire has been designed by a graduate student of the Environmental Science programme at Memorial University. The information gained will be used for research purposes.

Your participation in this survey is completely voluntary and at any time you can refuse to take part in it or to answer any of the questions below. It is also absolutely anonymous and none of the responding individuals will be identified in any way. After completing the survey please return it to one of the individuals providing the questionnaire.

Questions? Call 739-8801 or contact Rivendell Bongard at x69kjb@morgan.ucs.mun.ca.

Place an "X" in the appropriate box. Provide only one answer unless otherwise stated.

1/ Do you recycle? □ yes □ no

2/ What items do you recycle? (check "X" more than once if applicable)

□ refundable beverage containers (e.g. pop cans, plastic bottles, glass, tetra boxes, etc.)
□ non-refundable plastics (e.g. shampoo and dishwashing liquid containers)
□ corrugated cardboard
□ newspaper / flyers
□ office paper
□ mixed paper (e.g. magazines, catalogues, coloured paper, envelopes)
□ other (explain) _____

3/ How many beverages per day do you consume while on campus?

□ 0 □ 1 □ 2 □ 3 or more

4/ What do you do with your empty beverage containers?

□ dispose of in the garbage
□ return for a refund at one of the various refund depots (e.g. Ever Green, Nova)
□ donate to charity
□ other (explain) _____

5/ Would you participate in a recycling programme if a refund drop-off location was created on campus? □ yes □ no (explain)_____

6/ Will your participation depend on the distance to the closest recycling container / depot?

- ☐ no
- ☐ not if the containers are in sight
- ☐ will not participate if forced to go out of my way

7/ Do you think that recycling programmes are important in our society? ☐ yes ☐ no

8/ In your opinion, what would be the benefits of a deposit refund / recycling facility on the campus of Memorial University? (check "X" more than once if applicable)

- ☐ will create jobs
- ☐ will reduce the amount of waste generated by Memorial University
- ☐ will reduce the amount of waste entering local landfills
- ☐ will provide funding for Memorial University (e.g. Opportunity Fund)
- ☐ will provide an incentive to recycle
- ☐ do not know
- ☐ will not provide any benefits
- ☐ other (specify) _____

9/ Are you satisfied with Memorial University's present day efforts to reduce waste?

- ☐ satisfied
- ☐ unsatisfied
- ☐ unaware of any waste reduction practices
- ☐ do not care

10/ What is your gender?

☐ female ☐ male

11/ In which of the following age categories do you fall?

☐ 20 years and under ☐ 21-25 years ☐ 26-30 years ☐ 31-35 years
☐ 36-40 years ☐ 41-45 years ☐ more than 46 years

12/ What department are you associated with? (e.g. Department of Chemistry)

_____

Optional: Please use the space below to provide additional comments.

3.2 Questionnaire Results

For the most part, questions were completed fully and the nonresponse rate was minimal (2.7%). Of 298 sampled people a total of eight individuals did not want to participate in the survey for the following reasons: "too busy" or "not interested". Furthermore, six questionnaires were filled out only on one side and, if necessary, allowances were made for no response. Still, these 14 cases were accounted for in the preliminary calculations (a total of 60 nonusable questionnaires were allowed out of 298). The exact results are tabulated in Table 3.1.

During the sampling process, two questions (first and third) appeared to be vague. Therefore, these questions were disregarded from further analysis.

As mentioned above, the main objective of developing and implementing a questionnaire about recycling was to determine the participation factor of the general population at the main campus of Memorial University of Newfoundland, St. John's, Newfoundland, concerning the implementation of a recycling depot. The participation factor was calculated from the survey as follows:

Students	133	of	149	
Staff	132	of	145	
Custodians	4	of	4	
Total	269	of	298	**(90.3%)**

Standard error calculations (the measure to estimate sampling error; Salant and Dillman, 1994):

$$se\ (p) = \sqrt{\frac{pg}{n}}\ x\ 100$$

where se (p) = standard error of a proportion

p and q = the proportions of the sample that do (p) and do not (q) have a particular characteristic

n = number of elements in the sample

$$se\ (p) = \sqrt{\frac{(0.9)(0.1)}{298}}\ x\ 100 = 1.74\%$$

$$2 \times 1.74\% = 3.5\%$$

Therefore, the author is 95 per cent confident that between **86.5%** and **93.5%** (90% ± 3.5%) of the entire MUN population favour the potential refund depot location on campus, and between 6.5% and 13.5% (10% ± 3.5%) oppose it or do not care. For the calculation purposes the average value of 90% is used.

Overall, 75% of MUN's population recycle refundable beverage containers, 21% recycles non-refundable plastics, 19% recycles corrugated cardboard, 46% recycles newspaper, 53% recycles office paper, 32% recycles mixed paper and 6% recycles other

materials. Thirty-one percent of the surveyed population disposes of empty refundable beverage containers in the garbage, 29% returns them for a refund, 11% donates them to charity and 26% uses other options, e.g. present recycling bins on campus.

Thirty-seven per cent of the population states that their participation in a recycling program does not depend on the distance to the closest recycling container or a depot, 35% would participate as long as the recycling bins are in sight and 22% would not participate if forced out of the daily routine. Although 95% of people agreed that the recycling programmes are important in our society.

If a deposit/refund recycling facility was created on campus, it is believed to create jobs (53% of MUN's population), to reduce the amount of waste generated by Memorial University (77%) and entering local landfills (73%), to provide funding for Memorial University (e.g. Opportunity Fund; 39%), to provide an incentive to recycle (64%) and to provide other benefits (1%), e.g. by educating the community. Only 1% of the population cannot see any benefits of such a facility.

As far as the existing recycling system at MUN is concerned, 30% of the population is satisfied with the university present efforts, 42% is not satisfied, 21% is unaware of any waste reduction practices and 1% do not care. Please see Appendix E for the public comments on the subject.

Table 3.1 - Questionnaire Results

Question (short forms)	Students	Staff	Custodians	Overall	%
1. Do you recycle?					
yes	112	134	4	250	84
no	30	10	0	40	13
no answer	7	1	0	8	3
2. What items do you recycle?					
refundables	104	115	4	223	75
nonrefund plastics	26	37	0	63	21
cardboard	21	32	3	56	19
newspaper	58	75	3	136	46
office paper	55	101	3	159	53
mixed paper	32	60	2	94	32
other	8	9	0	17	6
no answer	7	1	0	8	3
3. How many beverages\day do you consume on campus?					
0	15	42	1	58	19
1	71	62	3	136	46
2	38	28	0	66	22
3 or more	18	10	0	28	9
no answer	7	3	0	10	3
4. What do you do with empty beverage containers?					
dispose of in garbage	50	41	1	92	31
return for refund	34	52	1	87	29
donate to charity	13	19	0	32	11
other	48	27	3	78	26
no answer	7	15	0	22	7
5. Would you participate in recycling on campus?					
yes	133	132	4	269	90
no	9	12	0	21	7
no answer	7	1	0	8	3
6. Will it depend on the distance to recycling facility?					
no	51	57	2	110	37
not if bins are in sight	54	47	2	103	35
yes if forced to go out of my way	32	30	0	62	21
no answer	12	11	0	23	8

continued on page 57

Table 3.1 - Questionnaire Results

Question (short forms)	Students	Staff	Custodians	Overall	%
7. Is recycling important?					
yes	137	141	4	282	95
no	0	1	0	1	0
no answer	12	3		15	5
Benefits of a depot on campus?					
will create jobs	82	74	3	159	53
will reduce waste at MUN	104	122	4	230	77
will reduce waste at landfills	100	113	4	217	73
funding for MUN	60	54	3	117	39
incentive to recycle	85	103	4	192	64
do not know	4	1	0	5	2
no benefits	1	1	0	2	1
other	3	3	0	6	2
no answer	12	3	0	15	5
9. Are you satisfied with MUN's present recycling efforts?					
satisfied	37	49	3	89	30
unsatisfied	66	57	1	124	42
unaware of any efforts	30	31	0	61	20
do not care	3	1	0	4	1
no answer	13	7	0	20	7
10. What is your gender?					
female	63	100	2	165	55
male	74	43	2	119	40
no answer	12	2	0	14	5
11. What is your age?					
20 years and under	20	1	0	21	7
21 - 25	90	9	0	99	33
26 - 30	17	22	0	39	13
31 - 35	8	37	1	46	15
36 - 40	0	19	1	20	7
41 - 45	1	19	0	20	7
46 and over	0	28	2	30	10
no answer	13	10	0	23	8

Chapter IV: Projected Materials Recovery Rates and Financial Values

4.1 Projected Materials Recovery Rates

The materials recovery rate (based on weight) is another way of expressing how efficient the present recycling programme is or how efficient the future one could be. The future values for materials recovery rates were calculated using the following formula (Tchobanoglous, Theisen and Vigil, 1993):

Materials recovery rate = Composition factor x Recovery factor x Participation factor

where Composition factor = fraction of waste component in total waste (expressed as a percentage)

Recovery factor = fraction of material recovered by a recycling programme (expressed in decimal form)

Participation factor = fraction of the public that participates in a recycling programme (expressed in decimal form)

Recall that the composition factor for each components can be observed on pages 39-42. The recovery factors were based on the solid waste audit results, industry specifications and present Newfoundland recycling guidelines (pages 42 - 44). The participation factor was determined by the questionnaire to be 90% (pages 53-54). MRR represents materials recovery rate.

Compostables

$MRR_{food\ waste} = 20.8\% \times 0.50 \times 0.90 = 9.36\%$

$MRR_{yard\ waste} = 2.7\% \times 1.00 \times 0.90 = 2.43\%$

Total = 11.79%

Recyclables

$MRR_{paper} = 26\% \times 0.60 \times 0.90 = 14.04\%$

$MRR_{cardboard} = 8.5\% \times 1.00 \times 0.90 = 7.65\%$

$MRR_{plastics} = 8.7\% \times 0.35 \times 0.90 = 2.74\%$

$MRR_{Tetra\ boxes} = 0.3\% \times 0.95 \times 0.90 = 0.26\%$

$MRR_{glass} = 5.0\% \times 0.95 \times 0.90 = 4.28\%$

$MRR_{aluminum} = 1.0\% \times 0.99 \times 0.90 = 0.89\%$

Total = 29.86%

Total (*compostables* + *recyclables*) = 41.65%

The above values state the percentage of MUN's main campus (sampling area) solid waste stream that can be diverted as recyclable and compostable materials. Therefore, 41.65% of MUN's solid waste stream can be diverted as recyclable and compostable materials.

Why is this value important? Knowing that MUN's solid waste collection expenses (committed) for 1997/98 year for the main campus (excluding the Health Sciences Centre) are $110,000 and that 41.65% of solid waste can be diverted, it could be projected that Memorial University could **save $45,815** (this value only refers to the sampling area).

4.2 Projected Revenue for a Recycling Depot Set Up on the Main Campus

Using the data from the compilation sheets (Appendix C), it was possible to determine the overall revenue generated from researched samples. The total number of non-alcoholic and liquor containers was tallied for each quartered sample. These values were then multiplied by four to obtain an overall sample value. Recall that non-alcoholic and liquor containers are worth three and ten cents respectively. The tabulated data can be observed in Table 4.1 on page 62. The final value calculated for all containers is $119.22. This is true for 29 lifts of the weekly total of 133 in the sampling area.

After calculating this amount, a projected term value can be calculated. First, Schedule "B" was consulted for the number of lifts per week in the sampling area during the spring/summer term. The following calculations were performed:

Total number of lifts sampled = 29

Total number of lifts during the spring/summer term with respect to the sampling locations = 133 lifts/week x 17 weeks = 2,261 lifts

Hence, 29 samples/ 2,261 lifts x 100 = 1.3%

Therefore, 29 sampled lifts constitutes 1.3% of the total number of lifts during the spring/summer term.

Recall 29 lifts generated $119.22. Therefore, the estimated revenue lost (R) by landfilling refundable recyclables can be calculated by cross-multiplication:

Table 4.1 - Refundable Containers in Sampled Solid Waste Stream

Sample	Number of NON-alcoholic containers for total sample	Available refunds (3 cents per container) ($)	Number of liquor containers (including beer)	Available refunds (10 cents per container) ($)	Total refund per sample ($)
1	52	1.56	0	0	1.56
2	132	3.96	0	0	3.96
3	36	1.08	0	0	1.08
4	360	10.80	8	0.8	11.6
5	76	2.28	0	0	2.28
6	112	3.36	124	12.4	15.76
7	284	8.52	0	0	8.52
8	360	10.80	0	0	10.8
9	268	8.04	0	0	8.04
10	92	2.76	0	0	2.76
11	0	0.00	0	0	0
12	8	0.24	0	0	0.24
13	20	0.60	8	0.8	1.4
14	76	2.28	0	0	2.28
15	184	5.52	0	0	5.52
16	100	3.00	0	0	3
17	20	0.60	0	0	0.6
18	256	7.68	0	0	7.68
19	3	0.09	16	1.6	1.69
20	116	3.48	0	0	3.48
21	27	0.81	2	0.2	1.01
22	2	0.06	1	0.1	0.16
23	140	4.20	0	0	4.2
24	60	1.80	0	0	1.8
25	140	4.20	0	0	4.2
26	40	1.20	0	0	1.2
27	76	2.28	0	0	2.28
28	164	4.92	48	4.8	9.72
29	80	2.40	0	0	2.4
Total	3284	98.52	207	20.7	119.22

Note: For exact sample locations see Appendix C.

29 / 2,261 = \$119.22 / R_{ss}, where R_{ss} is the estimated revenue lost during the spring/summer term.

R_{ss} = \$9,295.05

Hence, it was projected from the data obtained during the sampling programme that \$9,295.05 was lost as landfilled refundables for the spring/summer term due to the present solid waste management procedures.

From Schedule "B", the total number of lifts for the entire MUN campus during the spring/summer term is 2,941 lifts. Therefore, 2,261 lifts in the sampling area constitute 77% of the total number of lifts during the spring/summer term. Hence, it was assumed that \$9,295.05 represents approximately 77% of the refundable recyclable materials presently disposed of through landfilling practices. It should be stated that the MUN population for the spring/summer term is, as stated before, 7,444.

The MUN population for the fall and winter terms are 12,952 and 13,132 for each term respectively. Also, the increase in the number of lifts during the fall and winter terms is only 0.1%. Using this information, the author extrapolated the value of refundable recyclables for the fall and winter terms.

Fall	Winter
7,444 / 12,952 = \$9,295 / R_f	7,444 / 13,132 = \$9,295 / R_w
R_f = \$16,173	R_w = \$16,397

Therefore, for the combined three semesters the total amount of lost revenue is:

$R = R_s + R_f + R_w = \$9,295 + \$16,173 + \$16,397 = \mathbf{\$41,865}$

It was extrapolated that in the sampling area (77% of the entire campus) a revenue of $41,865 was lost in the form of landfilled refundable recyclables over an academic year. It must be noted that the above value is only a projection and only covers 77% of the entire MUN campus. Also, the fall and winter values could be higher than estimated. Furthermore, this value does not include external sources of refundable materials from residential properties.

Note: This report is not a feasibility study to determine financial gains that could be attained if a refund depot was implemented at the main campus of Memorial University, St. John's, Newfoundland. Therefore, capital and operating costs were not taken into consideration during these calculations.

4.3 Estimated Revenue of Beverage Containers from On-Campus Sources

The following calculations consider only beverage vending machines on the campus of Memorial University. The existing beverage vending machine across campus are administered by two independent bodies. The first floor of the Thomson Student Centre has seven machines which are governed by the Council of Students Union. The remaining 49 machines on campus are administered by Nova Services.

The estimated number of beverages purchased from the vending machines on campus per annum equals 378, 216 refundable beverage containers. Therefore, 378,216 refundable containers from beverage vending machines sold per annum times three cents per container equals **$11,346.48**.

If the participation rate is 90%, as acquired from the questionnaire, the value of $10, 212 can be recovered.

Chapter V: Conclusions and Recommendations

Alternatives to landfilling various components of the waste stream are created everyday (e.g. Refuse Derived Fuel). However, until solid wastes generated by the society are 100% environmentally friendly, the solid waste manager must provide plans and procedures that are efficient and ecological. Memorial University of Newfoundland needs a comprehensive solid waste management policy as soon as possible, designed to reduce the amount of waste going into the landfills and discarded as litter. The fact that 13.1% of the waste stream constitutes of compostable and 33.2% of recyclable materials which could be diverted must be addressed. Appropriate management could reduce the present expenditures of $110,000 per annum for the main campus by 42% to $64,000.

Furthermore, cooperation with the Waterford Hospital Foundation can transform the recyclable postconsumer waste into at least $42,000 revenue annually. By rewarding the return of recyclable and refillable containers there is an initiative to keep them out of the trash and turn them into cash. Also, approximately 460 short tons of compostable waste could be diverted into compost (humus) and condition local topsoil.

Overall, the University could gain the reputation of an environmentally responsible one, generate revenue for The Opportunity Fund and assist a non-profit organization which has already established a strong positive image in the community.

5.1 Recommendations

As the only university in Newfoundland and Labrador, MUN has a responsibility to do its part in waste reduction efforts. By setting an example and educating the general public about the importance of recycling, the University has the opportunity to change the future of the province. The following recommendations were concluded after this study:

1/ A comprehensive solid waste management and recycling policy should be developed for Memorial University to provide stable long-term guidelines for designing short-term goals and activities. Waste reduction guides, designed specifically for each department, should be created to educate faculty, staff and students about the 3Rs alternatives.

2/ Source separation is the first stage in the hierarchy of integrate solid waste management. Present day waste reduction initiatives in public areas (e.g. cafeterias, classrooms, libraries) should be focused on capturing greater amounts of recyclable materials, especially white paper, newsprint, and beverage containers, while office routines could be enhanced to capture more recyclable paper waste (enough containers should be supplied). Alternative avenues of waste reduction associated with frequent activities should be explored, e.g. through selective buying patterns administered by MUN upper management, a practice of reusing products where possible, replacement of paper towels in the washrooms with hand dryers and other environmentally friendly devices, etc. (University of South Carolina, 1997).

Daily operations should be studied to determine where waste is being generated and if the 3Rs are being practised:

- reduce (e.g. purchase materials with reduced packaging);
- reuse (e.g. select products which come in reusable containers or packages);
- recycle.

It is also very important that MUN custodial staff is trained with respect to how the recycling programme works. A system of obtaining regular feedback from these individuals should be established.

3/ A frequent reason for starting a recycling programme is to reduce the waste collection costs. Concentrating waste reduction efforts on "high volume" materials (e.g. unbroken corrugated cardboard which at present constitutes approximately 25% of waste volume) while source separating and collecting "high value" items (e.g. all of the refundable beverage containers) would substantially decrease waste collection costs, especially now when they are based on the number of lifts (University of South Carolina, 1997).

4/ A successful recycling and waste reduction programme on the Memorial University campus is absolutely dependent upon ample student and employee involvement. Reducing solid waste generated by the public is a learning process. Continuing education is essential, but the final decision is up to the individual. Promoting the findings of this report and other available data related to waste reduction and recycling activities, especially programme

achievements, would increase public awareness and participation. Promotional activities in the early stages of a recycling programme are crucial to the initial participation (Quinte Regional Recycling, 1993). Various educational demonstrations and events should be conducted on campus while media coverage should be strongly encouraged.

5/ The amount and size of visual aids for recycling activities should be considerably increased. Prominent, eye-catching posters with simple messages would educate and accustom the public on an every day basis. Bold signs for the recycling containers would instruct and put pressure on people who do not recycle. Precise marking, appropriate design of containers (e.g. holes for cans, slots for paper) and locking container lids would assist in preventing the contamination of homogenous recycling components and forcing users to flatten corrugated cardboard. Also, posting information on recyclable materials, especially those that are refundable if a sub-depot is set up on the main campus, would decrease present confusion about what is and what is not recyclable.

6/ Collection containers should be located where the recyclables are being generated (Pennsylvania Department of Environmental Protection, 1997). There should be sufficient amounts of recyclable containers for separate components on the main floor of each building. MUN residences should be provided with recycling centres on each floor, too. Furthermore, landfilling and contamination of recyclables can be minimized by locating trash cans next to the recycling containers. As confirmed by the questionnaire results,

majority of people are willing to recycle if the bins are fairly close and recycling is neither time consuming nor labourious. The easier it is to recycle the higher the participation rate will be (Pennsylvania Department of Environmental Protection, 1997). Recycling designs and initiatives must be made simple, so that not only the "converted" as well as the "uninitiated" will participate.

7/ Each department should organize food waste drop-off locations. This would allow students, staff and faculty members to separate biodegradable materials from the waste stream. Vermicomposting units can be purchased or developed by the biology department. These systems are presently used at other major universities in Canada (e.g. Queen's University).

The shortage of humus in the topsoil on the sports fields and garden areas on campus is quite evident. By composting food and yard wastes and adding the finished product, compost, to the existing topsoil plants will be provided with more nutrients while increasing the soil's ability to retain water. High quality compost, produced by grounds crews, could divert tons of biodegradable waste from MUN's solid waste stream and, in turn, save the University thousands of dollars in waste collection fees while producing a soil conditioner that reduces the need to purchase topsoil from off campus sources.

Food and yard wastes should be placed in clear plastic bags to ensure that handlers are aware of the contents. Ground keepers and kitchen staff must coordinate convenient times for the biodegradable organics to be taken to the designated composting site. These

food wastes should be added to yard wastes. Ground maintenance supervisors must reinform all staff members of the importance of diverting biodegradable yard wastes from dumpsters, especially during the spring and fall cleanups.

8/ Tin cans (2.6% of MUN's solid waste stream) could be easily separated from the solid waste stream. Kitchen and cafeteria staff could separate and drop off large volume tin containers daily in a provided scrap metal bins, e.g. by Newfoundland Recycling Ltd. - buyers of all types of scrap metal who provide container service.

9/ A system for the collection and diversion of construction wastes should be provided. Contractors engaged in building renovations must be encouraged to use the existing recycling collection systems.

10/ Once the recycling programme has been implemented, a second audit should be performed (Pennsylvania Department of Environmental Protection, 1997). Performing bi-annual waste stream audits would assist MUN in observing fluctuations and possible decreases in the amounts of various waste components. It would also help in making necessary adjustments to the current recycling programme.

11/ By networking with other Canadian universities about successes and failures concerning their recycling programmes solutions can be provided to problems that have

not yet occurred.

12/ If a sub-depot is implemented on the main campus of Memorial University, the revenue generated should be divided between the Memorial University and the Waterford Hospital Foundation. The author believes that both parties should set aside a small amount of funding for a scholarship fund for students enrolled in environmental science or engineering at Memorial University. Awards should be presented to those individuals who specialize in waste management or recycling related topics.

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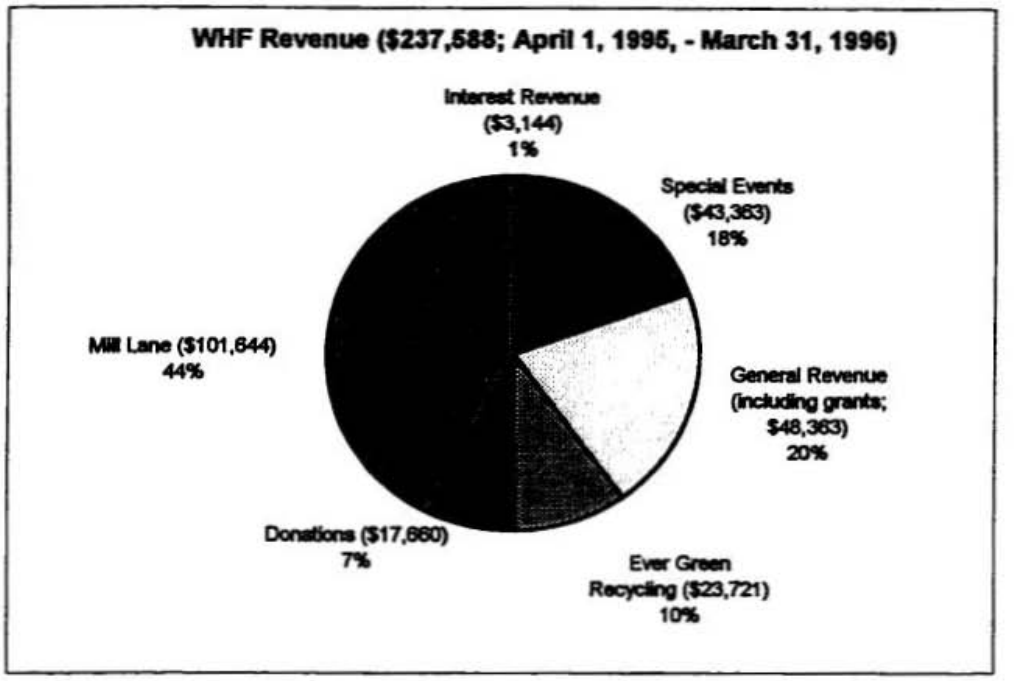
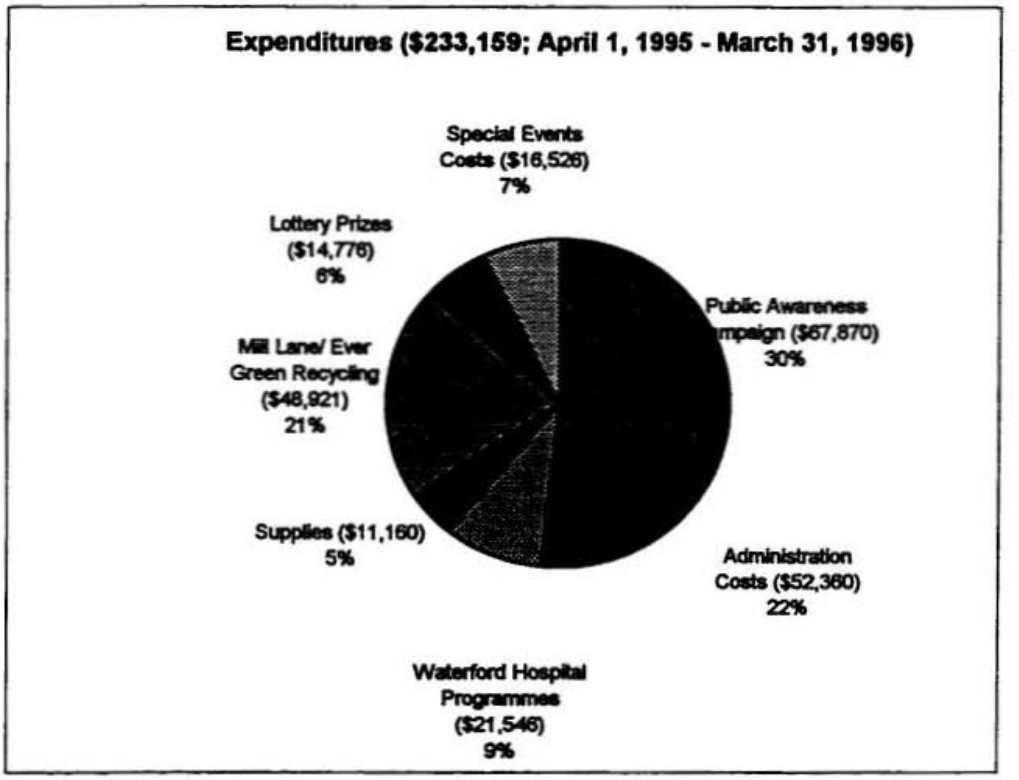
Appendix A


WHF Revenue ($237,588; April 1, 1995, - March 31, 1996)
Interest Revenue ($3,144) 1%
Special Events ($43,363) 18%
General Revenue (including grants; $48,363) 20%
Ever Green Recycling ($23,721) 10%
Donations ($17,660) 7%
Mill Lane ($101,844) 44%


Expenditures ($233,159; April 1, 1995 - March 31, 1996)
Special Events Costs ($16,526) 7%
Lottery Prizes ($14,776) 6%
Public Awareness ($67,870) 30%
Mill Lane/ Ever Green Recycling ($48,921) 21%
Supplies ($11,160) 5%
Administration Costs ($52,360) 22%
Waterford Hospital Programmes ($21,546) 9%

Appendix B

Memorial University Campus Site Plan (Scale 1:2000) Legend

The following symbols apply to the Memorial University Campus Site Plan (Scale 1:2000) located in the back sleeve of the report:

 → red dots represent solid waste collection containers of 6 yds^3

 → green dots represent solid waste collection containers of 4 yds^3

→ yellow dot represents solid waste collection containers of 2 yds^3

 → blue dots represent recycling collection containers

9 → numbers represent solid waste collection locations

Number	Dumpster Location
1	Ingstad Building
7	Education Building
8	Incinerator/Utilities Annex
10	QEII Library
12	Thomson Student Centre
13	Arts and Administration Building
20	Chemistry-Physics Building
21	Science Building
22	Henrietta Harvey Building
25	Services Building
29	St.John's College
30A	Rothermere and Barnes Residence
30C	Main Dining Hall
30F	Curtis and Squire
30H	Hatcher House
30I	Doyle and Blackall
31	Coughlan College and Spencer Hall
34	Queen's College
36	Day Care Centre
40A	Baltimore Apartments
40C	Cabot Apartments
40D	Cartier Apartments
40E	Gilbert Apartments
40F	Guy Apartment

Appendix C

Solid waste audit - data compilation sheet # 1

Location: Thomson Student Centre
Date/time: Friday, July 4,1997 / 7:40 P.M.
Container size: 6 cubic yards
Number of containers: 2 (there are additional recycling containers on site)
Estimated volume of waste: 4 cubic yards
Estimated volume of the quartered sample (includes unbroken cardboard): 1 cubic yard
Total weight of the quartered sample (lb.): 93.6

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	1.5	0.1035	192	240	48	51.3	25.9
Paper	1	0.0690	192	206	14	15.0	17.3
Cardboard (flat)	1.25	0.0863	192	206	14	15.0	21.6
Plastics	0.75	0.0518	192	194	2	2.1	12.9
Textiles & rubber	0	0.0000	192	192	0	0.0	0.0
Tetra boxes	0.07	0.0048	192	192.1	0.1	0.1	1.2
Yard Waste	0	0.0000	192	192	0	0.0	0.0
Wood	0.05	0.0035	192	192.2	0.2	0.2	0.9
Glass	0.05	0.0035	192	192.2	0.2	0.2	0.9
Tin Cans	0	0.0000	192	192	0	0.0	0.0
Aluminum	0.125	0.0086	192	192.1	0.1	0.1	2.2
Other Metals	0	0.0000	192	192	0	0.0	0.0
"True" garbage	1	0.0690	192	207	15	16.0	17.3
TOTAL	5.795	0.3999			93.6	100.0	100.0

"Aluminum" cans: 8
Plastic beverage bottles: 1
Tetrapacks: 3
Refundable tin cans: 0

Glass beverage bottles: 1
Liquor bottles: 0
Beer bottles: 0

Solid waste audit - data compilation sheet # 2

Location: Guy (residence)
Date/time: Tuesday, July 8,1997 / 12:50 P.M.
Container size: 6 cubic yards
Number of containers: 1
Estimated volume of waste: 6 cubic yards
Estimated volume of the quartered sample (includes unbroken cardboard): 2 cubic yards
Total weight of the quartered sample (lb.): 99.8

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.67	0.0462	190	202	12	12.0	6.2
Paper	2.5	0.1725	190	207	17	17.0	23.3
Cardboard (flat)	1	0.0690	190	196	6	6.0	9.3
Plastics	2.4	0.1656	190	198	8	8.0	22.3
Textiles & rubber	0.1	0.0069	190	190.2	0.2	0.2	0.9
Tetra boxes	0.17	0.0117	190	190.2	0.2	0.2	1.6
Yard Waste	1	0.0690	190	204	14	14.0	9.3
Wood	0	0.0000	190	190	0	0.0	0.0
Glass	0.2	0.0138	190	195	5	5.0	1.9
Tin Cans	0.5	0.0345	190	193	3	3.0	4.7
Aluminum	0.2	0.0138	190	190.4	0.4	0.4	1.9
Other Metals	0	0.0000	190	190	0	0.0	0.0
"True" garbage	2	0.1380	190	224	34	34.1	18.6
TOTAL	10.74	0.7411			99.8	100.0	100.0

"Aluminum" cans: 14
Plastic beverage bottles: 8
Tetrapacks: 8
Refundable tin cans: 0

Glass beverage bottles: 3
Liquor bottles: 0
Beer bottles: 0

Solid waste audit - data compilation sheet # 3

Location: Gilbert (residence)
Date/time: Tuesday, July 8,1997 / 12:55 P.M.
Container size: 6 cubic yards
Number of containers: 1
Estimated volume of waste: 4 cubic yards
Estimated volume of the quartered sample (includes unbroken cardboard): 1 cubic yard
Total weight of the quartered sample (lb.): 65.5

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	1	0.0690	190	210	20	30.5	16.3
Paper	1.5	0.1035	190	210	20	30.5	24.4
Cardboard (flat)	0.67	0.0462	190	193	3	4.6	10.9
Plastics	1.2	0.0828	190	193	3	4.6	19.5
Textiles & rubber	0.33	0.0228	190	191	1	1.5	5.4
Tetra boxes	0.1	0.0069	190	190.1	0.1	0.2	1.6
Yard Waste	0	0.0000	190	190	0	0.0	0.0
Wood	0	0.0000	190	190	0	0.0	0.0
Glass	0	0.0000	190	190	0	0.0	0.0
Tin Cans	0.17	0.0117	190	190.2	0.2	0.3	2.8
Aluminum	0.13	0.0090	190	190.1	0.1	0.2	2.1
Other Metals	0.05	0.0035	190	190.1	0.1	0.2	0.8
"True" garbage	1	0.0690	190	208	18	27.5	16.3
TOTAL	6.15	0.4244			65.5	100.0	100.0

"Aluminum" cans: 2
Plastic beverage bottles: 1
Tetrapacks: 6
Refundable tin cans: 0

Glass beverage bottles: 0
Liquor bottles: 0
Beer bottles: 0

Solid waste audit - data compilation sheet # 4

Location: Cartier (residence)
Date/time: Tuesday, July 8,1997 / 1:00 P.M.
Container size: 6 cubic yards
Number of containers: 1
Estimated volume of waste: 4 cubic yards
Estimated volume of the quartered sample (includes unbroken cardboard): 1 cubic yard
Total weight of the quartered sample (lb.): 69.8

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.5	0.0345	188	202	14	20.1	5.7
Paper	2	0.1380	188	202	14	20.1	23.0
Cardboard (flat)	0.5	0.0345	188	190	2	2.9	5.7
Plastics	2.5	0.1725	188	196.5	8.5	12.2	28.7
Textiles & rubber	0.2	0.0138	188	188.2	0.2	0.3	2.3
Tetra boxes	0.17	0.0117	188	188.1	0.1	0.1	2.0
Yard Waste	0	0.0000	188	188	0	0.0	0.0
Wood	0	0.0000	188	188	0	0.0	0.0
Glass	0.2	0.0138	188	193	5	7.2	2.3
Tin Cans	0.5	0.0345	188	193	5	7.2	5.7
Aluminum	0.84	0.0580	188	193	5	7.2	9.6
Other Metals	0.1	0.0069	188	190	2	2.9	1.1
"True" garbage	1.2	0.0828	188	202	14	20.1	13.8
TOTAL	8.71	0.6010			69.8	100.0	100.0

"Aluminum" cans: 73
Plastic beverage bottles: 13
Tetrapacks: 3
Refundable tin cans: 0

Glass beverage bottles: 1
Liquor bottles: 2
Beer bottles: 0

Solid waste audit - data compilation sheet # 5

Location: Baltimore (residence)
Date/time: Tuesday, July 8,1997 / 1:10 P.M.
Container size: 6 cubic yards
Number of containers: 1
Estimated volume of waste: 3 cubic yards
Estimated volume of the quartered sample (includes unbroken cardboard): 1 cubic yard
Total weight of the quartered sample (lb.): 47

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.75	0.0518	190	205.5	15.5	33.0	16.3
Paper	1	0.0690	190	200	10	21.3	21.7
Cardboard (flat)	1	0.0690	190	196	6	12.8	21.7
Plastics	1	0.0690	190	193	3	6.4	21.7
Textiles & rubber	0	0.0000	190	190	0	0.0	0.0
Tetra boxes	0.1	0.0069	190	190	0	0.0	2.2
Yard Waste	0.1	0.0069	190	190.4	0.4	0.9	2.2
Wood	0	0.0000	190	190	0	0.0	0.0
Glass	0.1	0.0069	190	193	3	6.4	2.2
Tin Cans	0.2	0.0138	190	194	4	8.5	4.3
Aluminum	0.1	0.0069	190	190.1	0.1	0.2	2.2
Other Metals	0	0.0000	190	190	0	0.0	0.0
"True" garbage	0.25	0.0173	190	195	5	10.6	5.4
TOTAL	4.6	0.3174			47	100.0	100.0

"Aluminum" cans: 9
Plastic beverage bottles: 5
Tetrapacks: 4
Refundable tin cans: 0

Glass beverage bottles: 1
Liquor bottles: 0
Beer bottles: 0

Solid waste audit - data compilation sheet # 6

Location: Cabot (residence)
Date/time: Tuesday, July 8,1997 / 1:15 P.M.
Container size: 6 cubic yards
Number of containers: 1
Estimated volume of waste: 3 cubic yards
Estimated volume of the quartered sample (includes unbroken cardboard): 1 cubic yard
Total weight of the quartered sample (lb.): 83.2

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.67	0.0462	188	204	16	19.2	8.8
Paper	1	0.0690	188	193	5	6.0	13.2
Cardboard (flat)	0.67	0.0462	188	190	2	2.4	8.8
Plastics	2.2	0.1518	188	194	6	7.2	29.0
Textiles & rubber	0	0.0000	188	188	0	0.0	0.0
Tetra boxes	0.1	0.0069	188	188.1	0.1	0.1	1.3
Yard Waste	0	0.0000	188	188	0	0.0	0.0
Wood	0	0.0000	188	188	0	0.0	0.0
Glass	0.67	0.0462	188	205	17	20.4	8.8
Tin Cans	0.33	0.0228	188	191	3	3.6	4.3
Aluminum	0.2	0.0138	188	188.1	0.1	0.1	2.6
Other Metals	0	0.0000	188	188	0	0.0	0.0
"True" garbage	1.75	0.1208	188	222	34	40.9	23.1
TOTAL	7.59	0.5237			83.2	100.0	100.0

"Aluminum" cans: 10
Plastic beverage bottles: 11
Tetrapacks: 3
Refundable tin cans: 1

Glass beverage bottles: 3
Liquor bottles: 1
Beer bottles: 30

Solid waste audit - data compilation sheet # 7

Location: Education Building
Date/time: Wednesday, July 9,1997 / 8:40 P.M.
Container size: 6 cubic yards
Number of containers: 1
Estimated volume of waste: 3 cubic yards
Estimated volume of the quartered sample (includes unbroken cardboard): 0.8 cubic yard
Total weight of the quartered sample (lb.): 33.4

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.1	0.0069	188	189	1	3.0	1.9
Paper	1	0.0690	188	204	16	47.9	19.3
Cardboard (flat)	0.1	0.0069	188	188.9	0.9	2.7	1.9
Plastics	1.75	0.1208	188	192	4	12.0	33.8
Textiles & rubber	0	0.0000	188	188	0	0.0	0.0
Tetra boxes	0.2	0.0138	188	189	1	3.0	3.9
Yard Waste	0	0.0000	188	188	0	0.0	0.0
Wood	0	0.0000	188	188	0	0.0	0.0
Glass	0.2	0.0138	188	190	2	6.0	3.9
Tin Cans	0.33	0.0228	188	190	2	6.0	6.4
Aluminum	0.5	0.0345	188	188.5	0.5	1.5	9.7
Other Metals	0	0.0000	188	188	0	0.0	0.0
"True" garbage	1	0.0690	188	194	6	18.0	19.3
TOTAL	5.18	0.3574			33.4	100.0	100.0

"Aluminum" cans: 44
Plastic beverage bottles: 2
Tetrapacks: 18
Refundable tin cans: 0

Glass beverage bottles: 7
Liquor bottles: 0
Beer bottles: 0

Solid waste audit - data compilation sheet # 8

Location: Arts and Administration
Date/time: Wednesday, July 9,1997 / 8:55 P.M.
Container size: 6 cubic yards
Number of containers: 1
Estimated volume of waste: 4 cubic yards
Estimated volume of the quartered sample (includes unbroken cardboard): 1 cubic yard
Total weight of the quartered sample (lb.): 51.5

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.2	0.0138	188	192	4	7.8	2.4
Paper	2	0.1380	188	205	17	33.0	24.5
Cardboard (flat)	0.5	0.0345	188	193	5	9.7	6.1
Plastics	2	0.1380	188	193	5	9.7	24.5
Textiles & rubber	0.1	0.0069	188	188.4	0.4	0.8	1.2
Tetra boxes	0.1	0.0069	188	188.1	0.1	0.2	1.2
Yard Waste	0	0.0000	188	188	0	0.0	0.0
Wood	0	0.0000	188	188	0	0.0	0.0
Glass	0.17	0.0117	188	192	4	7.8	2.1
Tin Cans	0.1	0.0069	188	190	2	3.9	1.2
Aluminum	1	0.0690	188	190	2	3.9	12.2
Other Metals	0	0.0000	188	188	0	0.0	0.0
"True" garbage	2	0.1380	188	200	12	23.3	24.5
TOTAL	8.17	0.5637			51.5	100.0	100.0

"Aluminum" cans: 73
Plastic beverage bottles: 7
Tetrapacks: 4
Refundable tin cans: 0

Glass beverage bottles: 6
Liquor bottles: 0
Beer bottles: 0

Solid waste audit - data compilation sheet # 9

Location: Thomson Student Centre
Date/time: Wednesday, July 9,1997 / 9:15 P.M.
Container size: 6 cubic yards
Number of containers: 2
Estimated volume of waste: 4 cubic yards
Estimated volume of the quartered sample (includes unbroken cardboard): 1 cubic yard
Total weight of the quartered sample (lb.): 75.1

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.67	0.0462	188	216	28	37.3	6.4
Paper	1	0.0690	188	190	2	2.7	9.5
Cardboard (flat)	0.1	0.0069	188	188.3	0.3	0.4	1.0
Plastics	6	0.4140	188	204	16	21.3	57.2
Textiles & rubber	0	0.0000	188	188	0	0.0	0.0
Tetra boxes	0.2	0.0138	188	188.1	0.1	0.1	1.9
Yard Waste	0	0.0000	188	188	0	0.0	0.0
Wood	0	0.0000	188	188	0	0.0	0.0
Glass	0.25	0.0173	188	194	6	8.0	2.4
Tin Cans	0.1	0.0069	188	188.2	0.2	0.3	1.0
Aluminum	0.5	0.0345	188	188.5	0.5	0.7	4.8
Other Metals	0	0.0000	188	188	0	0.0	0.0
"True" garbage	1.67	0.1152	188	210	22	29.3	15.9
TOTAL	10.49	0.7238			75.1	100.0	100.0

"Aluminum" cans: 37
Plastic beverage bottles: 5
Tetrapacks: 11
Refundable tin cans: 0

Glass beverage bottles: 14
Liquor bottles: 0
Beer bottles: 0

Solid waste audit - data compilation sheet # 10

Location: Queen Elizabeth II Library
Date/time: Thursday, July 10,1997 / 8:35 P.M.
Container size: 6 cubic yards
Number of containers: 1 (there is also a green container for recyclables on site)
Estimated volume of waste: 6 cubic yards
Estimated volume of the quartered sample (includes unbroken cardboard): 1.5 cubic yards
Total weight of the quartered sample (lb.): 282.1

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.2	0.0138	188	192	4	1.4	2.0
Paper	6	0.4140	188	446	258	91.5	60.7
Cardboard (flat)	1	0.0690	188	195	7	2.5	10.1
Plastics	1.33	0.0918	188	192	4	1.4	13.4
Textiles & rubber	0	0.0000	188	188	0	0.0	0.0
Tetra boxes	0.03	0.0021	188	188.1	0.1	0.0	0.3
Yard Waste	0	0.0000	188	188	0	0.0	0.0
Wood	0	0.0000	188	188	0	0.0	0.0
Glass	0.05	0.0035	188	188.5	0.5	0.2	0.5
Tin Cans	0.03	0.0021	188	188.1	0.1	0.0	0.3
Aluminum	0.25	0.0173	188	188.4	0.4	0.1	2.5
Other Metals	0	0.0000	188	188	0	0.0	0.0
"True" garbage	1	0.0690	188	196	8	2.8	10.1
TOTAL	9.89	0.6824			282.1	100.0	100.0

"Aluminum" cans: 16
Plastic beverage bottles: 3
Tetrapacks: 1
Refundable tin cans: 1

Glass beverage bottles: 2
Liquor bottles: 0
Beer bottles: 0

Solid waste audit - data compilation sheet # 11

Location: Ingstad Building (printing facility)
Date/time: Thursday, July 10,1997 / 9:05 P.M.
Container size: 6 cubic yards
Number of containers: 1
Estimated volume of waste: 2 cubic yards
Estimated volume of the quartered sample (includes unbroken cardboard): 0.5 cubic yards
Total weight of the quartered sample (lb.): 26

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0	0.0000	188	188	0	0.0	0.0
Paper	2.25	0.1553	188	213	25	96.2	76.3
Cardboard (flat)	0	0.0000	188	188	0	0.0	0.0
Plastics	0.5	0.0345	188	188.4	0.4	1.5	16.9
Textiles & rubber	0	0.0000	188	188	0	0.0	0.0
Tetra boxes	0	0.0000	188	188	0	0.0	0.0
Yard Waste	0	0.0000	188	188	0	0.0	0.0
Wood	0	0.0000	188	188	0	0.0	0.0
Glass	0	0.0000	188	188	0	0.0	0.0
Tin Cans	0	0.0000	188	188	0	0.0	0.0
Aluminum	0	0.0000	188	188	0	0.0	0.0
Other Metals	0	0.0000	188	188	0	0.0	0.0
"True" garbage	0.2	0.0138	188	188.6	0.6	2.3	6.8
TOTAL	2.95	0.2036			26	100.0	100.0

"Aluminum" cans: 0
Plastic beverage bottles: 0
Tetrapacks: 0
Refundable tin cans: 0

Glass beverage bottles: 0
Liquor bottles: 0
Beer bottles: 0

Solid waste audit - data compilation sheet # 12

Location: Day Care Centre
Date/time: Thursday, July 10,1997 / 9:20 P.M.
Container size: 4 cubic yards
Number of containers: 1
Estimated volume of waste: 0.8 cubic yard
Estimated volume of the quartered sample (includes unbroken cardboard): 0.2 cubic yard
Total weight of the quartered sample (lb.): 13.3

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.17	0.0117	190	191	1	7.5	7.6
Paper	1	0.0690	190	195	5	37.6	44.8
Cardboard (flat)	0	0.0000	190	190	0	0.0	0.0
Plastics	0.5	0.0345	190	191	1	7.5	22.4
Textiles & rubber	0	0.0000	190	190	0	0.0	0.0
Tetra boxes	0	0.0000	190	190	0	0.0	0.0
Yard Waste	0	0.0000	190	190	0	0.0	0.0
Wood	0	0.0000	190	190	0	0.0	0.0
Glass	0.03	0.0021	190	190.2	0.2	1.5	1.3
Tin Cans	0.03	0.0021	190	190.1	0.1	0.8	1.3
Aluminum	0	0.0000	190	190	0	0.0	0.0
Other Metals	0	0.0000	190	190	0	0.0	0.0
"True" garbage	0.5	0.0345	190	196	6	45.1	22.4
TOTAL	2.23	0.1539			13.3	100.0	100.0

"Aluminum" cans: 0
Plastic beverage bottles: 1
Tetrapacks: 0
Refundable tin cans: 0

Glass beverage bottles: 1
Liquor bottles: 0
Beer bottles: 0

Solid waste audit - data compilation sheet # 13

Location: Queen's College (undergoing renovations)
Date/time: Thursday, July 10,1997 / 9:30 P.M.
Container size: 6 cubic yards
Number of containers: 1
Estimated volume of waste: 1.5 cubic yards
Estimated volume of the quartered sample (includes unbroken cardboard): 0.5 cubic yard
Total weight of the quartered sample (lb.): 35.7

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.03	0.0021	190	190.2	0.2	0.6	0.6
Paper	0.5	0.0345	190	192	2	5.6	10.6
Cardboard (flat)	1	0.0690	190	194	4	11.2	21.1
Plastics	1	0.0690	190	192	2	5.6	21.1
Textiles & rubber	0	0.0000	190	190	0	0.0	0.0
Tetra boxes	0	0.0000	190	190	0	0.0	0.0
Yard Waste	0	0.0000	190	190	0	0.0	0.0
Wood	0.1	0.0069	190	192	2	5.6	2.1
Glass	0.05	0.0035	190	192	2	5.6	1.1
Tin Cans	0.25	0.0173	190	191.5	1.5	4.2	5.3
Aluminum	0.05	0.0035	190	190	0	0.0	1.1
Other Metals	0.75	0.0518	190	198	8	22.4	15.9
"True" garbage	1	0.0690	190	204	14	39.2	21.1
TOTAL	4.73	0.3264			35.7	100.0	100.0

"Aluminum" cans: 3
Plastic beverage bottles: 0
Tetrapacks: 0
Refundable tin cans: 2

Glass beverage bottles: 0
Liquor bottles: 2
Beer bottles: 0

Solid waste audit - data compilation sheet # 14

Location: Arts and Administration
Date/time: Friday, July 11,1997 / 12:35 P.M.
Container size: 6 cubic yards
Number of containers: 1
Estimated volume of waste: 2 cubic yards
Estimated volume of the quartered sample (includes unbroken cardboard): 0.5 cubic yard
Total weight of the quartered sample (lb.): 20.5

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.2	0.0138	188	191	3	14.6	6.0
Paper	0.75	0.0518	188	193	5	24.4	22.7
Cardboard (flat)	0	0.0000	188	188	0	0.0	0.0
Plastics	1	0.0690	188	190	2	9.8	30.2
Textiles & rubber	0	0.0000	188	188	0	0.0	0.0
Tetra boxes	0.03	0.0021	188	188.1	0.1	0.5	0.9
Yard Waste	0	0.0000	188	188	0	0.0	0.0
Wood	0	0.0000	188	188	0	0.0	0.0
Glass	0.05	0.0035	188	190	2	9.8	1.5
Tin Cans	0.03	0.0021	188	188.1	0.1	0.5	0.9
Aluminum	0.25	0.0173	188	188.3	0.3	1.5	7.6
Other Metals	0	0.0000	188	188	0	0.0	0.0
"True" garbage	1	0.0690	188	196	8	39.0	30.2
TOTAL	3.31	0.2284			20.5	100.0	100.0

"Aluminum" cans: 14
Plastic beverage bottles: 3
Tetrapacks: 1
Refundable tin cans: 0

Glass beverage bottles: 1
Liquor bottles: 0
Beer bottles: 0

Solid waste audit - data compilation sheet # 15

Location: Thomson Student Centre
Date/time: Friday, July 11,1997 / 1:05 P.M.
Container size: 6 cubic yards
Number of containers: 2
Estimated volume of waste: 2 cubic yards in one container, one is empty
Estimated volume of the quartered sample (includes unbroken cardboard): 0.5 cubic yard
Total weight of the quartered sample (lb.): 21.7

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.2	0.0138	188	191	3	13.8	4.6
Paper	0.5	0.0345	188	190	2	9.2	11.5
Cardboard (flat)	0	0.0000	188	188	0	0.0	0.0
Plastics	2	0.1380	188	192	4	18.4	45.9
Textiles & rubber	0	0.0000	188	188	0	0.0	0.0
Tetra boxes	0.03	0.0021	188	188.1	0.1	0.5	0.7
Yard Waste	0	0.0000	188	188	0	0.0	0.0
Wood	0	0.0000	188	188	0	0.0	0.0
Glass	0.1	0.0069	188	189	1	4.6	2.3
Tin Cans	0.03	0.0021	188	188.1	0.1	0.5	0.7
Aluminum	0.5	0.0345	188	188.5	0.5	2.3	11.5
Other Metals	0	0.0000	188	188	0	0.0	0.0
"True" garbage	1	0.0690	188	199	11	50.7	22.9
TOTAL	4.36	0.3008			21.7	100.0	100.0

"Aluminum" cans: 38
Plastic beverage bottles: 4
Tetrapacks: 1
Refundable tin cans: 0

Glass beverage bottles: 3
Liquor bottles: 0
Beer bottles: 0

Solid waste audit - data compilation sheet # 16

Location: Chemistry
Date/time: Friday, July 11,1997 / 3:50 P.M.
Container size: 6 cubic yards
Number of containers: 2
Estimated volume of waste: 4 cubic yards in one container, one is empty
Estimated volume of the quartered sample (includes unbroken cardboard): 1 cubic yard
Total weight of the quartered sample (lb.): 64.4

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.2	0.0138	188	193	5	7.8	2.6
Paper	1	0.0690	188	196	8	12.4	13.0
Cardboard (flat)	0.5	0.0345	188	189.5	1.5	2.3	6.5
Plastics	1.5	0.1035	188	195	7	10.9	19.4
Textiles & rubber	0	0.0000	188	188	0	0.0	0.0
Tetra boxes	0.2	0.0138	188	188.2	0.2	0.3	2.6
Yard Waste	2.67	0.1842	188	214	26	40.4	34.6
Wood	0	0.0000	188	188	0	0.0	0.0
Glass	0.05	0.0035	188	188.2	0.2	0.3	0.6
Tin Cans	0.2	0.0138	188	188.3	0.3	0.5	2.6
Aluminum	0.2	0.0138	188	188.2	0.2	0.3	2.6
Other Metals	0	0.0000	188	188	0	0.0	0.0
"True" garbage	1.2	0.0828	188	204	16	24.8	15.5
TOTAL	7.72	0.5327			64.4	100.0	100.0

"Aluminum" cans: 14
Plastic beverage bottles: 1
Tetrapacks: 8
Refundable tin cans: 0

Glass beverage bottles: 2
Liquor bottles: 0
Beer bottles: 0
1 recyclable HP LaserJet Toner Cartridge 92298A

Solid waste audit - data compilation sheet # 17

Location: Science Building
Date/time: Friday, July 11,1997 / 4:10 P.M.
Container size: 6 cubic yards
Number of containers: 2
Estimated volume of waste: 4 cubic yards in one container, one is empty
Estimated volume of the quartered sample (includes unbroken cardboard): 1 cubic yard
Total weight of the quartered sample (lb.): 59.6

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.1	0.0069	188	189	1	1.7	1.2
Paper	2	0.1380	188	210	22	36.9	23.6
Cardboard (flat)	1.25	0.0863	188	196	8	13.4	14.8
Plastics	1.75	0.1208	188	192	4	6.7	20.7
Textiles & rubber	0.33	0.0228	188	190	2	3.4	3.9
Tetra boxes	0.03	0.0021	188	188.1	0.1	0.2	0.4
Yard Waste	0	0.0000	188	188	0	0.0	0.0
Wood	0.05	0.0035	188	189	1	1.7	0.6
Glass	0.05	0.0035	188	189	1	1.7	0.6
Tin Cans	0.1	0.0069	188	188.4	0.4	0.7	1.2
Aluminum	0.05	0.0035	188	188.1	0.1	0.2	0.6
Other Metals	0	0.0000	188	188	0	0.0	0.0
"True" garbage	2.75	0.1898	188	208	20	33.6	32.5
TOTAL	8.46	0.5837			59.6	100.0	100.0

"Aluminum" cans: 3
Plastic beverage bottles: 0
Tetrapacks: 1
Refundable tin cans: 0

Glass beverage bottles: 1
Liquor bottles: 0
Beer bottles: 0

Solid waste audit - data compilation sheet # 18

Location: Coughlan College and Spencer Hall
Date/time: Friday, July 11,1997 / 7:15 P.M.
Container size: 6 cubic yards
Number of containers: 1
Estimated volume of waste: 2 cubic yards
Estimated volume of the quartered sample (includes unbroken cardboard): 0.5 cubic yard
Total weight of the quartered sample (lb.): 27.1

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.2	0.0138	188	192	4	14.8	3.9
Paper	1	0.0690	188	193	5	18.5	19.6
Cardboard (flat)	0.05	0.0035	188	188.1	0.1	0.4	1.0
Plastics	1.75	0.1208	188	193	5	18.5	34.3
Textiles & rubber	0.05	0.0035	188	188.2	0.2	0.7	1.0
Tetra boxes	0.1	0.0069	188	188.1	0.1	0.4	2.0
Yard Waste	0.5	0.0345	188	192	4	14.8	9.8
Wood	0	0.0000	188	188	0	0.0	0.0
Glass	0.03	0.0021	188	188.1	0.1	0.4	0.6
Tin Cans	0	0.0000	188	188	0	0.0	0.0
Aluminum	0.67	0.0462	188	188.6	0.6	2.2	13.1
Other Metals	0	0.0000	188	188	0	0.0	0.0
"True" garbage	0.75	0.0518	188	196	8	29.5	14.7
TOTAL	5.1	0.3519			27.1	100.0	100.0

"Aluminum" cans: 60
Plastic beverage bottles: 1
Tetrapacks: 2
Refundable tin cans: 0

Glass beverage bottles: 1
Liquor bottles: 0
Beer bottles: 0

Solid waste audit - data compilation sheet # 19

Location: Main Dining Hall
Date/time: Monday, July 14,1997 / 12:30 P.M.
Container size: 6 cubic yards
Number of containers: 2
Estimated volume of waste: 0.5 cubic yard in one, one is not used
The entire sample was examined since it was significantly small. During three earlier check-ups both containers were empty.
Total weight of the quartered sample (lb.): 73.2

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	1.25	0.0863	190	248	58	79.2	22.2
Paper	0.25	0.0173	190	190.5	0.5	0.7	4.4
Cardboard (flat)	0.33	0.0228	190	190.5	0.5	0.7	5.9
Plastics	1	0.0690	190	190.8	0.8	1.1	17.8
Textiles & rubber	0	0.0000	190	190	0	0.0	0.0
Tetra boxes	0.05	0.0035	190	190.1	0.1	0.1	0.9
Yard Waste	2	0.1380	190	195	5	6.8	35.6
Wood	0	0.0000	190	190	0	0.0	0.0
Glass	0.33	0.0228	190	196	6	8.2	5.9
Tin Cans	0.05	0.0035	190	190.2	0.2	0.3	0.9
Aluminum	0.03	0.0021	190	190.1	0.1	0.1	0.5
Other Metals	0	0.0000	190	190	0	0.0	0.0
"True" garbage	0.33	0.0228	190	192	2	2.7	5.9
TOTAL	5.62	0.3878			73.2	100.0	100.0

"Aluminum" cans: 1
Plastic beverage bottles: 1
Tetrapacks: 1
Refundable tin cans: 0

Glass beverage bottles: 0
Liquor bottles: 4
Beer bottles: 12

Solid waste audit - data compilation sheet # 20

Location: Curtis and Squire (residence)
Date/time: Monday, July 14,1997 / 12:40 P.M.
Container size: 4 cubic yards
Number of containers: 1
Estimated volume of waste: 2 cubic yards
Estimated volume of the quartered sample (includes unbroken cardboard): 0.5 cubic yard
Total weight of the quartered sample (lb.): 36

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.33	0.0228	188	198	10	27.8	5.8
Paper	1	0.0690	188	198	10	27.8	17.5
Cardboard (flat)	0.67	0.0462	188	190	2	5.6	11.7
Plastics	1.75	0.1208	188	194	6	16.7	30.6
Textiles & rubber	0	0.0000	188	188	0	0.0	0.0
Tetra boxes	0.2	0.0138	188	188.2	0.2	0.6	3.5
Yard Waste	0	0.0000	188	188	0	0.0	0.0
Wood	0	0.0000	188	188	0	0.0	0.0
Glass	0.1	0.0069	188	188.3	0.3	0.8	1.7
Tin Cans	0.17	0.0117	188	188.3	0.3	0.8	3.0
Aluminum	0.25	0.0173	188	188.2	0.2	0.6	4.4
Other Metals	0	0.0000	188	188	0	0.0	0.0
"True" garbage	1.25	0.0863	188	195	7	19.4	21.9
TOTAL	5.72	0.3947			36	100.0	100.0

"Aluminum" cans: 18
Plastic beverage bottles: 7
Tetrapacks: 3
Refundable tin cans: 0

Glass beverage bottles: 1
Liquor bottles: 0
Beer bottles: 0

Solid waste audit - data compilation sheet # 21

Location: Hatcher House
Date/time: Monday, July 14,1997 / 12:55 P.M.
Container size: 6 cubic yards
Number of containers: 2
Estimated volume of waste: 0.5 cubic yard
* The entire sample was taken due to its small size.
Total weight of the sample (lb.): 52.3

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.5	0.0345	188	208	20	38.2	8.9
Paper	1	0.0690	188	194	6	11.5	17.8
Cardboard (flat)	1	0.0690	188	194	6	11.5	17.8
Plastics	1.5	0.1035	188	192	4	7.6	26.6
Textiles & rubber	0	0.0000	188	188	0	0.0	0.0
Tetra boxes	0.1	0.0069	188	188.1	0.1	0.2	1.8
Yard Waste	0	0.0000	188	188	0	0.0	0.0
Wood	0	0.0000	188	188	0	0.0	0.0
Glass	0.2	0.0138	188	192	4	7.6	3.6
Tin Cans	0.33	0.0228	188	192	4	7.6	5.9
Aluminum	0.25	0.0173	188	188.2	0.2	0.4	4.4
Other Metals	0	0.0000	188	188	0	0.0	0.0
"True" garbage	0.75	0.0518	188	196	8	15.3	13.3
TOTAL	5.63	0.3885			52.3	100.0	100.0

"Aluminum" cans: 11
Plastic beverage bottles: 11
Tetrapacks: 3
Refundable tin cans: 1

Glass beverage bottles: 1
Liquor bottles: 2
Beer bottles: 0

Solid waste audit - data compilation sheet # 22

Location: Doyle and Blackall (residence)
Date/time: Monday, July 14,1997 / 1:05 P.M.
Container size: 6 cubic yards
Number of containers: 1
Estimated volume of waste: 0.5 cubic yard
* The whole sample was taken due to its small size.
Total weight of the quartered sample (lb.): 60.8

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.2	0.0138	190	192	2	3.3	4.0
Paper	2	0.1380	190	228	38	62.5	40.2
Cardboard (flat)	1	0.0690	190	204	14	23.0	20.1
Plastics	1	0.0690	190	194	4	6.6	20.1
Textiles & rubber	0	0.0000	190	190	0	0.0	0.0
Tetra boxes	0	0.0000	190	190	0	0.0	0.0
Yard Waste	0	0.0000	190	190	0	0.0	0.0
Wood	0.1	0.0069	190	190.2	0.2	0.3	2.0
Glass	0.1	0.0069	190	190.3	0.3	0.5	2.0
Tin Cans	0.05	0.0035	190	190.2	0.2	0.3	1.0
Aluminum	0.03	0.0021	190	190.1	0.1	0.2	0.6
Other Metals	0	0.0000	190	190	0	0.0	0.0
"True" garbage	0.5	0.0345	190	192	2	3.3	10.0
TOTAL	4.98	0.3436			60.8	100.0	100.0

"Aluminum" cans: 1
Plastic beverage bottles: 1
Tetrapacks: 0
Refundable tin cans: 0

Glass beverage bottles: 0
Liquor bottles: 1
Beer bottles: 0

Solid waste audit - data compilation sheet # 23

Location: Thomson Student Centre
Date/time: Monday, July 14,1997 / 1:10 P.M.
Container size: 6 cubic yards
Number of containers: 2
Estimated volume of waste: 5 cubic yards in one, one empty
Estimated volume of the quartered sample (includes unbroken cardboard): 1.5 cubic yards
Total weight of the quartered sample (lb.): 56.2

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.25	0.0173	188	196	8	14.2	3.2
Paper	2	0.1380	188	210	22	39.1	25.8
Cardboard (flat)	1	0.0690	188	196	8	14.2	12.9
Plastics	2	0.1380	188	191	3	5.3	25.8
Textiles & rubber	0	0.0000	188	188	0	0.0	0.0
Tetra boxes	0.03	0.0021	188	188.1	0.1	0.2	0.4
Yard Waste	0	0.0000	188	188	0	0.0	0.0
Wood	0	0.0000	188	188	0	0.0	0.0
Glass	0.17	0.0117	188	188.4	0.4	0.7	2.2
Tin Cans	0.05	0.0035	188	188.2	0.2	0.4	0.6
Aluminum	0.5	0.0345	188	188.5	0.5	0.9	6.5
Other Metals	0	0.0000	188	188	0	0.0	0.0
"True" garbage	1.75	0.1208	188	202	14	24.9	22.6
TOTAL	7.75	0.5348			56.2	100.0	100.0

"Aluminum" cans: 26
Plastic beverage bottles: 3
Tetrapacks: 1
Refundable tin cans: 0

Glass beverage bottles: 5
Liquor bottles: 0
Beer bottles: 0

Solid waste audit - data compilation sheet # 24

Location: Main Dining Hall
Date/time: Thursday, July 17,1997 / 9:15 P.M.
Container size: 6 cubic yards
Number of containers: 2
Estimated volume of waste: 6 cubic yards in one (2/3 consist of unbroken cardboard), one empty
Estimated volume of the quartered sample (includes unbroken cardboard): 1.5 cubic yards
Total weight of the quartered sample (lb.): 56.7

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.67	0.0462	190	218	28	49.4	10.3
Paper	0.05	0.0035	190	190.1	0.1	0.2	0.8
Cardboard (flat)	3	0.2070	190	206	16	28.2	46.2
Plastics	1	0.0690	190	194	4	7.1	15.4
Textiles & rubber	0.03	0.0021	190	190.1	0.1	0.2	0.5
Tetra boxes	0	0.0000	190	190	0	0.0	0.0
Yard Waste	0	0.0000	190	190	0	0.0	0.0
Wood	0	0.0000	190	190	0	0.0	0.0
Glass	0	0.0000	190	190	0	0.0	0.0
Tin Cans	0.75	0.0518	190	194	4	7.1	11.5
Aluminum	0.5	0.0345	190	190.5	0.5	0.9	7.7
Other Metals	0	0.0000	190	190	0	0.0	0.0
"True" garbage	0.5	0.0345	190	194	4	7.1	7.7
TOTAL	6.5	0.4485			56.7	100.0	100.0

"Aluminum" cans: 13
Plastic beverage bottles: 0
Tetrapacks: 0
Refundable tin cans: 2

Glass beverage bottles: 0
Liquor bottles: 0
Beer bottles: 0

Solid waste audit - data compilation sheet # 25

Location: Hatcher House
Date/time: Thursday, July 17,1997 / 9:40 P.M.
Container size: 6 cubic yards
Number of containers: 2
Estimated volume of waste: 2 cubic yards in one, one empty
Estimated volume of the quartered sample (includes unbroken cardboard): 0.5 cubic yard
Total weight of the quartered sample (lb.): 22

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.05	0.0035	190	192	2	9.1	1.4
Paper	0.88	0.0607	190	202	12	54.5	24.4
Cardboard (flat)	0	0.0000	190	190	0	0.0	0.0
Plastics	1	0.0690	190	192	2	9.1	27.7
Textiles & rubber	0.2	0.0138	190	190.4	0.4	1.8	5.5
Tetra boxes	0.13	0.0090	190	190.1	0.1	0.5	3.6
Yard Waste	0	0.0000	190	190	0	0.0	0.0
Wood	0	0.0000	190	190	0	0.0	0.0
Glass	0.17	0.0117	190	191	1	4.5	4.7
Tin Cans	0.1	0.0069	190	190.2	0.2	0.9	2.8
Aluminum	0.33	0.0228	190	190.3	0.3	1.4	9.1
Other Metals	0	0.0000	190	190	0	0.0	0.0
"True" garbage	0.75	0.0518	190	194	4	18.2	20.8
TOTAL	3.61	0.2491			22	100.0	100.0

"Aluminum" cans: 25
Plastic beverage bottles: 4
Tetrapacks: 2
Refundable tin cans: 0

Glass beverage bottles: 4
Liquor bottles: 0
Beer bottles: 0

Solid waste audit - data compilation sheet # 26

Location: Thomson Student Centre
Date/time: Thursday, July 17,1997 / 9:45 P.M.
Container size: 6 cubic yards
Number of containers: 2
Estimated volume of waste: 6 cubic yards in one, one empty
Estimated volume of the quartered sample (includes unbroken cardboard): 1.5 cubic yard
Total weight of the quartered sample (lb.): 35.2

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.2	0.0138	190	195	5	14.2	3.1
Paper	0.33	0.0228	190	192	2	5.7	5.1
Cardboard (flat)	2	0.1380	190	200	10	28.4	31.2
Plastics	2	0.1380	190	194	4	11.4	31.2
Textiles & rubber	0	0.0000	190	190	0	0.0	0.0
Tetra boxes	0.05	0.0035	190	190.1	0.1	0.3	0.8
Yard Waste	0	0.0000	190	190	0	0.0	0.0
Wood	0	0.0000	190	190	0	0.0	0.0
Glass	0	0.0000	190	190	0	0.0	0.0
Tin Cans	0	0.0000	190	190	0	0.0	0.0
Aluminum	0.17	0.0117	190	190.1	0.1	0.3	2.6
Other Metals	0	0.0000	190	190	0	0.0	0.0
"True" garbage	1.67	0.1152	190	204	14	39.8	26.0
TOTAL	6.42	0.4430			35.2	100.0	100.0

"Aluminum" cans: 8
Plastic beverage bottles: 0
Tetrapacks: 2
Refundable tin cans: 0

Glass beverage bottles: 0
Liquor bottles: 0
Beer bottles: 0

Solid waste audit - data compilation sheet # 27

Location: Main Dining Hall
Date/time: Friday, July 18,1997 / 10:30 P.M.
Container size: 6 cubic yards
Number of containers: 2
Estimated volume of waste: 3 cubic yards in one (conference type waste), one empty
Estimated volume of the quartered sample (includes unbroken cardboard): 0.75 cubic yard
Total weight of the quartered sample (lb.): 46.6

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.5	0.0345	190	210	20	42.9	9.2
Paper	0.33	0.0228	190	192	2	4.3	6.1
Cardboard (flat)	2	0.1380	190	200	10	21.5	36.8
Plastics	1	0.0690	190	194	4	8.6	18.4
Textiles & rubber	0	0.0000	190	190	0	0.0	0.0
Tetra boxes	0	0.0000	190	190	0	0.0	0.0
Yard Waste	0	0.0000	190	190	0	0.0	0.0
Wood	0	0.0000	190	190	0	0.0	0.0
Glass	0.05	0.0035	190	190.5	0.5	1.1	0.9
Tin Cans	1	0.0690	190	195	5	10.7	18.4
Aluminum	0.05	0.0035	190	190.1	0.1	0.2	0.9
Other Metals	0	0.0000	190	190	0	0.0	0.0
"True" garbage	0.5	0.0345	190	195	5	10.7	9.2
TOTAL	5.43	0.3747			46.6	100.0	100.0

"Aluminum" cans: 3
Plastic beverage bottles: 5
Tetrapacks: 0
Refundable tin cans: 11

Glass beverage bottles: 0
Liquor bottles: 0
Beer bottles: 0

Solid waste audit - data compilation sheet # 28

Location: Hatcher House
Date/time: Friday, July 18,1997 / 11:00 P.M.
Container size: 6 cubic yards
Number of containers: 2
Estimated volume of waste: 2 cubic yards in one, one empty
Estimated volume of the quartered sample (includes unbroken cardboard): 0.5 cubic yard
Total weight of the quartered sample (lb.): 21.7

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.1	0.0069	190	192	2	9.2	2.1
Paper	0.67	0.0462	190	194	4	18.4	13.8
Cardboard (flat)	1	0.0690	190	194	4	18.4	20.7
Plastics	1	0.0690	190	191	1	4.6	20.7
Textiles & rubber	0	0.0000	190	190	0	0.0	0.0
Tetra boxes	0.1	0.0069	190	190.1	0.1	0.5	2.1
Yard Waste	0	0.0000	190	190	0	0.0	0.0
Wood	0	0.0000	190	190	0	0.0	0.0
Glass	0.67	0.0462	190	198	8	36.9	13.8
Tin Cans	0.05	0.0035	190	190.1	0.1	0.5	1.0
Aluminum	0.5	0.0345	190	190.5	0.5	2.3	10.3
Other Metals	0	0.0000	190	190	0	0.0	0.0
"True" garbage	0.75	0.0518	190	192	2	9.2	15.5
TOTAL	4.84	0.3340			21.7	100.0	100.0

"Aluminum" cans: 36
Plastic beverage bottles: 3
Tetrapacks: 1
Refundable tin cans: 0

Glass beverage bottles: 1
Liquor bottles: 1
Beer bottles: 11

Solid waste audit - data compilation sheet # 29

Location: Thomson Student Centre
Date/time: Friday, July 18,1997 / 11:10 P.M.
Container size: 6 cubic yards
Number of containers: 2
Estimated volume of waste: 2 cubic yards in one, one empty
Estimated volume of the quartered sample (includes unbroken cardboard): 0.5 cubic yard
Total weight of the quartered sample (lb.): 36.5

Component	Estimated volume of component (1 basket=52.9 L)	Estimated volume of component (cubic yards)	Sampler's weight plus basket (lb.)	Sampler plus component weight (lb.)	Component weight (lb.)	Percent by weight (%)	Percent by volume (%)
Food Waste	0.5	0.0345	188	202	14	38.4	9.0
Paper	0.2	0.0138	188	189	1	2.7	3.6
Cardboard (flat)	0.5	0.0345	188	191	3	8.2	9.0
Plastics	2.5	0.1725	188	192	4	11.0	45.0
Textiles & rubber	0	0.0000	188	188	0	0.0	0.0
Tetra boxes	0.1	0.0069	188	188.1	0.1	0.3	1.8
Yard Waste	0	0.0000	188	188	0	0.0	0.0
Wood	0	0.0000	188	188	0	0.0	0.0
Glass	0.05	0.0035	188	188.2	0.2	0.5	0.9
Tin Cans	0.5	0.0345	188	190	2	5.5	9.0
Aluminum	0.2	0.0138	188	188.2	0.2	0.5	3.6
Other Metals	0	0.0000	188	188	0	0.0	0.0
"True" garbage	1	0.0690	188	200	12	32.9	18.0
TOTAL	5.55	0.3830			36.5	100.0	100.0

"Aluminum" cans: 16
Plastic beverage bottles: 0
Tetrapacks: 3
Refundable tin cans: 0

Glass beverage bottles: 1
Liquor bottles: 0
Beer bottles: 0

Appendix D

Table 15-8 - *Typical specification for general-use compost produced from yard wastes*
(Tchobanoglous, Theisen, and Vigil, 1993)

Parameter	Units	Value		Remarks
		Range	Typical	
Cation exchange capacity, CEC	meq/100g[a]	20 - 60	No specs	
Conductivity	mmho/cm	No limits, t≤ 15	No specs	Parameter indicates soluble salts.
Foreign matter	%	0 - 2	No sharp, injurious material	Minnesota prohibits all foreign material.
Metals				
Cadmium	ppm[a]	4 - 10	10	Iowa has cumulative limits for all metals in lb/ac.yr, depending on cation exchange capacity of soil. California and Ohio require testing but have no limits.
Chromium	or	1000	1000	
Copper	mg/kg[a]	100 -1000	No typical	
Lead		250 - 500	No typical	
Mercury		5 - 10	No typical	
Nickel		100 - 200	No typical	
Zinc		200 - 2500	No typical	
Moisture	percent by dry weight	20 - 40	≤ 40	Only CA and MN have limits.
Nutrients	various	Nitrogen ≥ 1% NH_3:TKN[b] ≤ 10	No typical value	Only three states require analysis.
Odor	none	No specs or, not offensive	Not offensive	
Organic matter	%	No specs	No specs	Ohio and Minnesota require tests; no limits.
Pathogens	none	No pathogens, to PFRP[c]	No typical value	PFRP: Maintain 55°C for minimum of 3 days.
PCBs	ppm	No limits, to 1	No specs	Limit is 1 ppm for MN, NY.
pH	unitless	5.5 - 7.0	No typical	California requires ≥ 6.5.
Specific weight	lb/yd^3	No specs	No specs	
Stability (Reheat)	°C	No heat gain, to 38°C max. temp.	No heat gain	Minnesota requires C/N ratio between 12 and 25 to ensure completion of biological activity.
Vol. reduct.	%	No specs	No specs	
Texture	mm	10 - 13	10 - 13	Only two states have specifications.

[a] Based on dry weight of compost.
[b] TKN = total Kjeldahl nitrogen.
[c] PFRP: Process to further reduce pathogens; required if co-composting with sludge.

Appendix E

The following statements come from the optional questionnaire section provided for additional comments on recycling:

(a) *Students*

"Recycling programmes must be created that are: 1/ realistic 2/ actually implemented (as opposed to just hyped)."

"Something needs to be done about the amount of styrofoam and other paper containers going into the trash."

"The recycling efforts at MUN *#@?."

"I am actually just beginning to recycle as much as I can after taking notice of the amount of waste generated that can be recyclable."

"I know that Memorial has tried to participate in the recycling programme, but items being recycled are not being disposed of often; hence, this leads to many fruit flies in the cafeteria. I feel that if this system is to succeed, then the items being recycled should not be held in the bins for weeks at a time and the bins should be placed just outside the cafeteria."

"Recycling should not be a fad. People should reuse and reduce (i.e. reuse bottles)."

"Recycling is <u>essential</u> to the important task of waste reduction. Popular education is important to make recycling a habit for people."

"I am from Ontario where the city provides a recycling service and I would be glad to see one implemented by the university. I feel very guilty throwing away things that could be recycled."

"MUN must make a better effort to recycle. Get students to do it at home also."

(b) *MUN employees*

"I'm really unsure of all types of things that we are able to recycle. I live in C.B.S. and all things aren't acceptable at that depot."

"Although pleased that efforts are being made at MUN reg. recycling - I feel that there is

still more that could be done."

"TSC should have better recycling facilities."

"If a recycling depot was located on campus, I would drop off all my recyclable goods. I am not living near a recycling depot and it is very inconvenient for me to go out of my way to recycle."

"Convenient locations are important."

"We need more recycling bins - a blue box in every office is needed."

"Great idea! Make containers an easy access thing!"

"This is a very important initiative for the University to be part of (i.e. sets a good example of being involved in community)."

"I feel that more drop off locations should be provided. If not, "out of sight, out of mind".

"They once recycled shredded and normal white paper, but was informed that the custodial staff was dumping it in the dumpsters."

"I would participate as long as it was within reasonable range/access and well serviced."

"I long for a recycling program that can re-utilize virtually all "waste" generated by my household, and it would be efficient and job creating to have a regular "pick-up".

"I view the current system as simply another tax grab by the Nfld. government. I'm still P.O.'d about the surtax on my income."

"Recycling programmes require too much care on the part of the staff - look at the Nova paper recycling - it mostly goes in the garbage. Make the recycling organisation do the sorting, not the end user! Recycling is important in large cities i.e. metro Toronto, New York City. I don't believe the arguments are valid in small or rural communities like St. John's."

"Recycling will tax people more."

"There should be separate containers on each floor, one for paper, one for newspaper, one for glass, one for cans."

Appendix F

Photo 1: Estimating volume of a solid waste sample.

Photo 2: Typical solid waste sample.

Photo 3: Separating a solid waste sample.

Photo 4: Transferring a solid waste sample.

Photo 5: Determining the overall weight of a quartered sample.

Photo 6: Sorting of waste components.

Photo 7: Recycling bin for cardboard, paper and cans.

Photo 8: Typical separated solid waste sample.

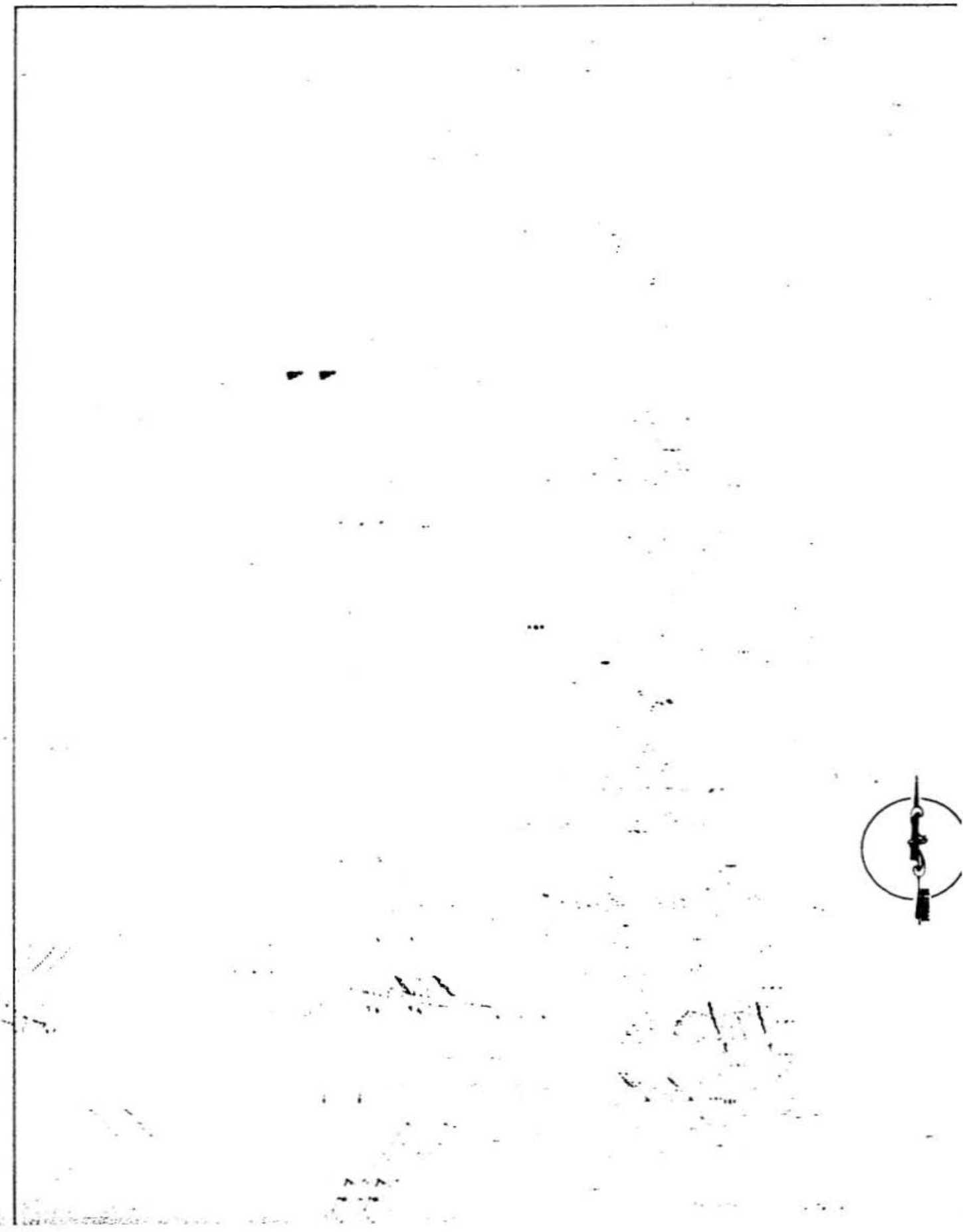
Photo 9: Solid waste sample composed of compostable grass clippings.

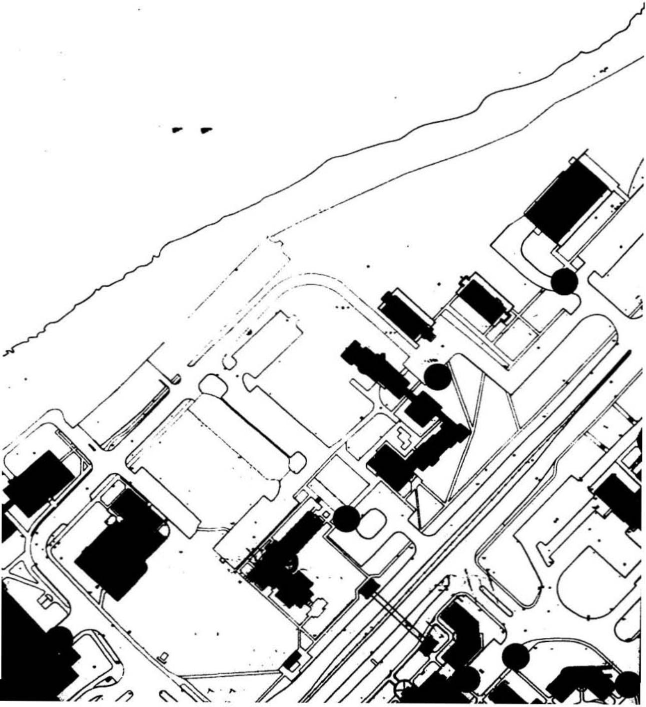
Photo 10: Topsoil sample purchased off campus.

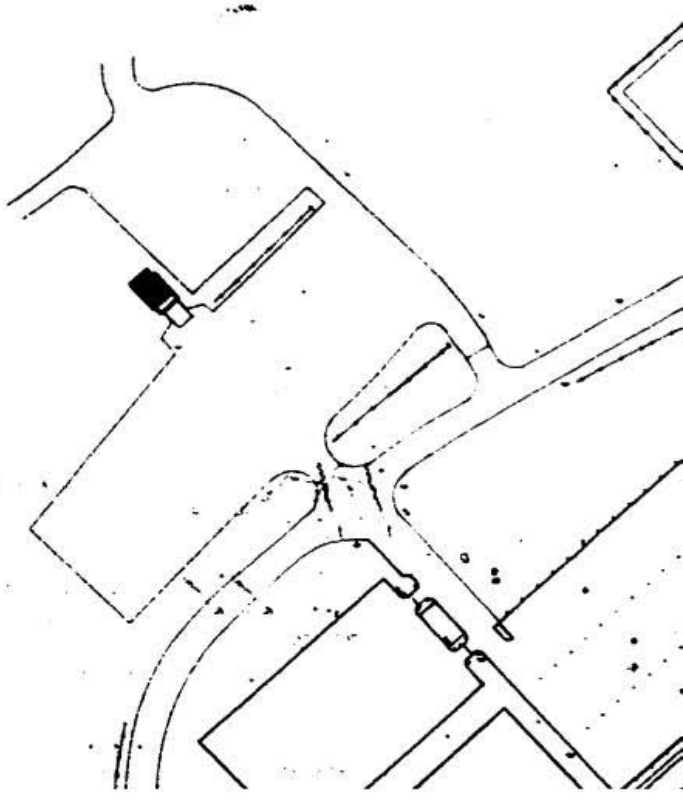
Photo 11: Typical topsoil on campus.

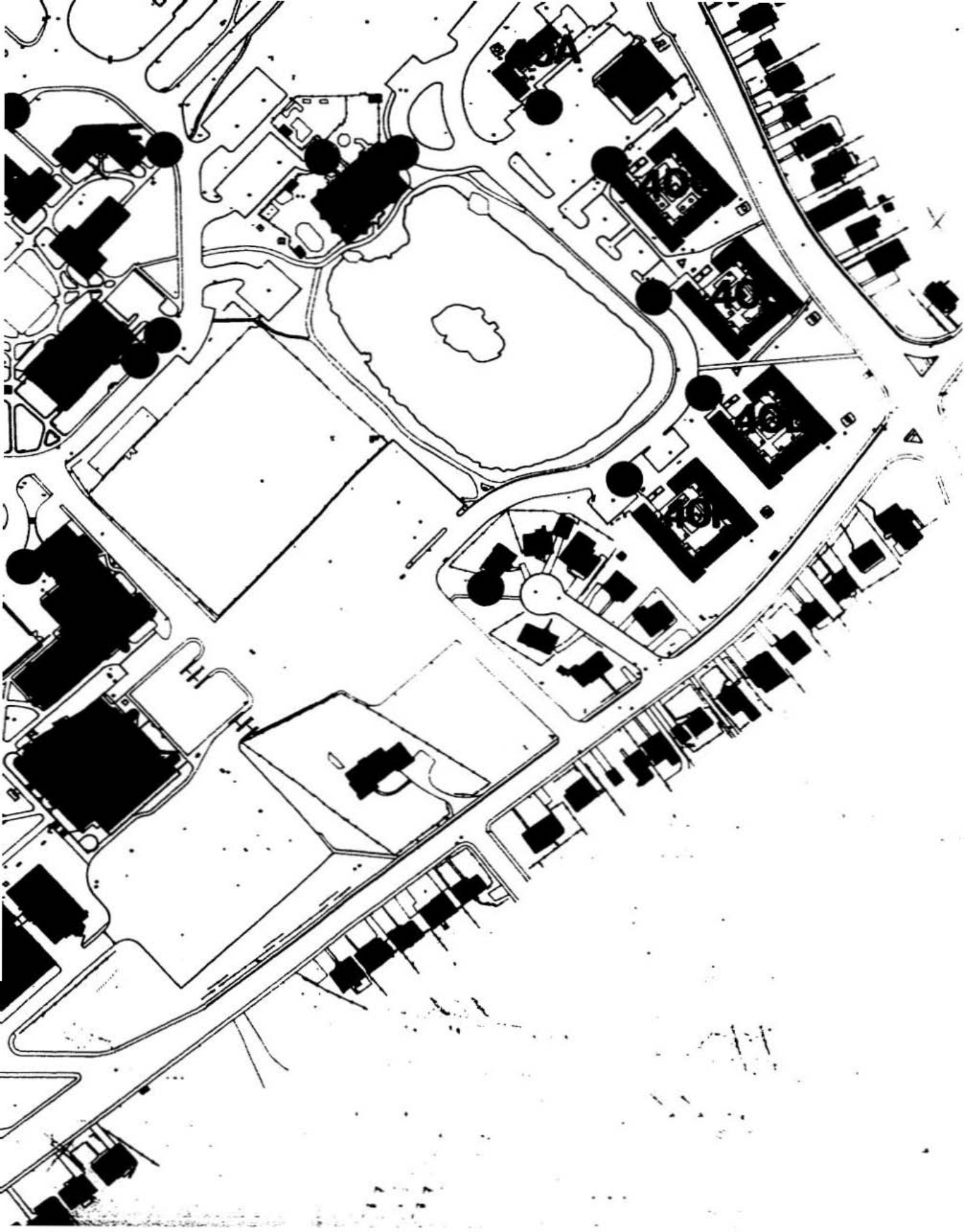
Photo 12: Recyclables recovered from MUN's solid waste.

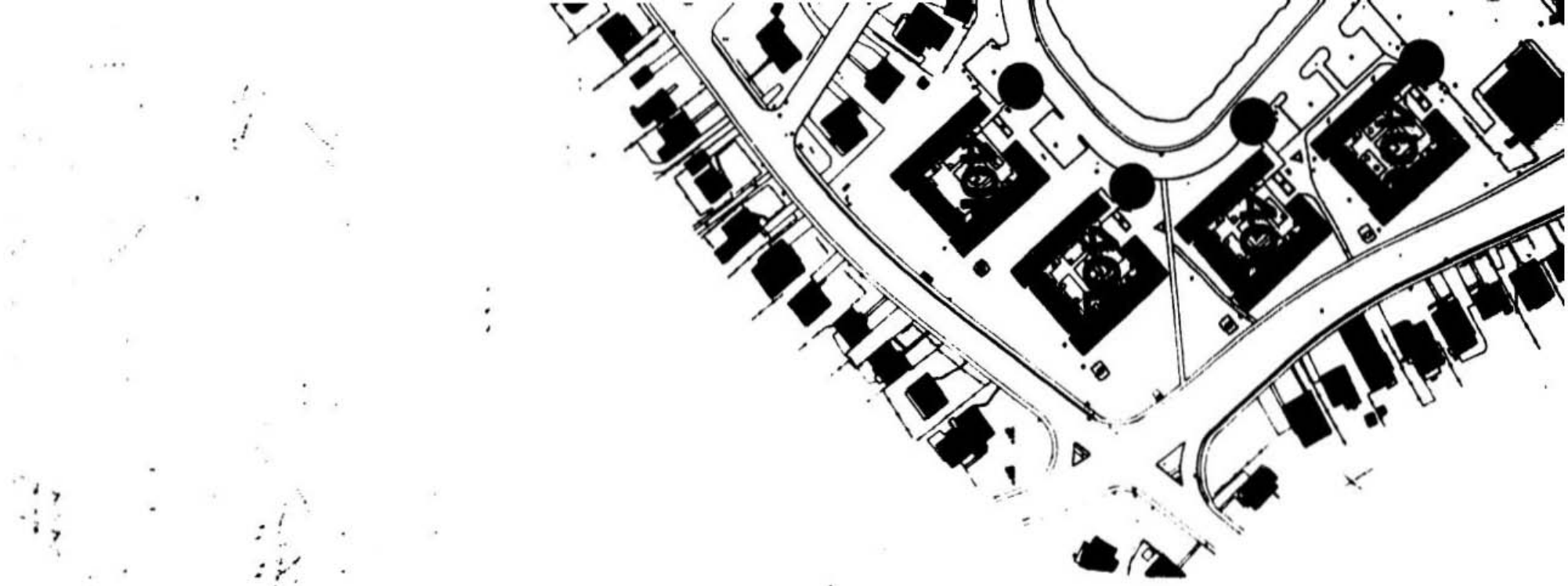
Photo 13: Examples of refundable recyclables (Ever Green display).

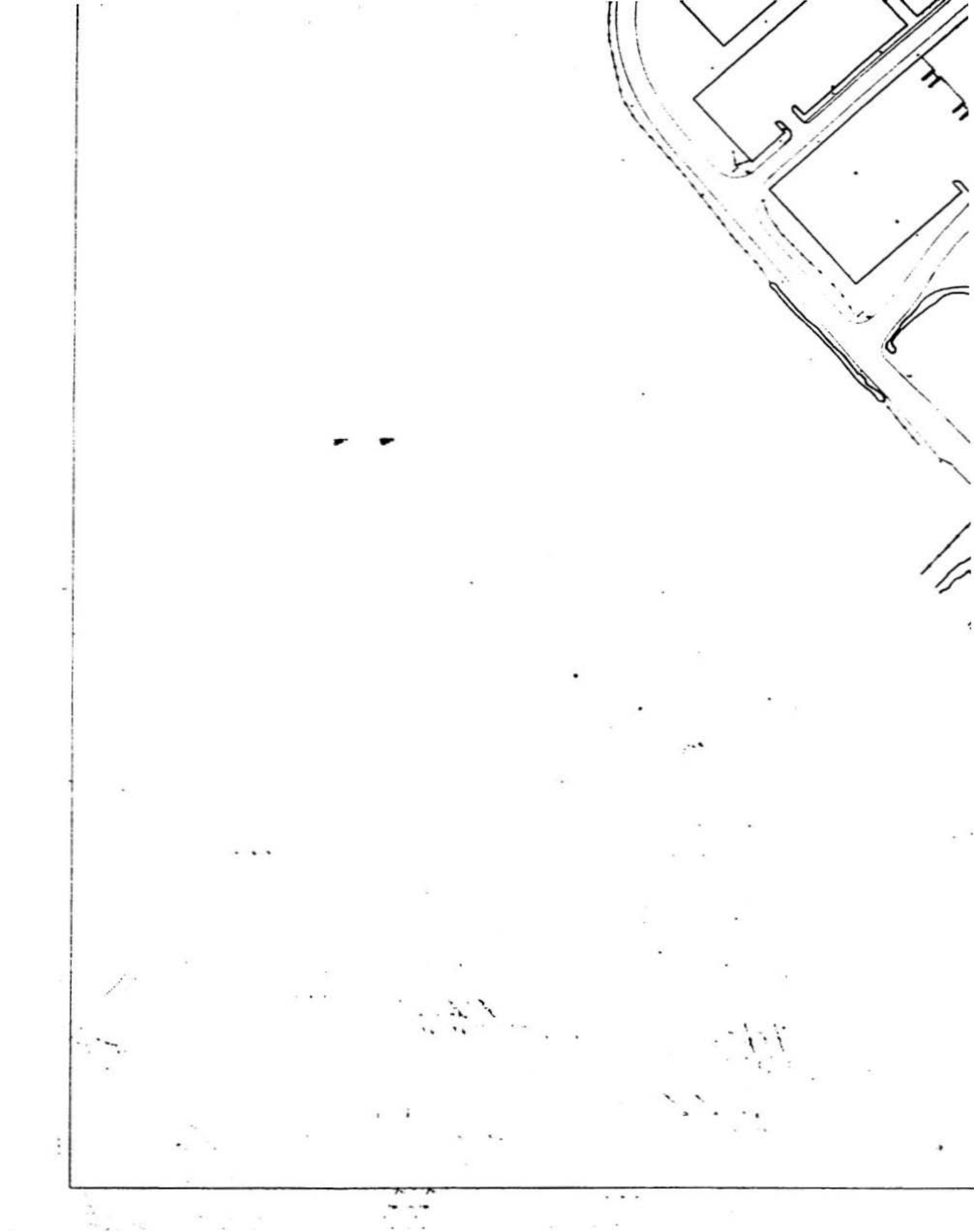












MEMORIAL UNIVERSITY CAMPUS

SITE PLAN

1 : 2000

SITY CAMPUS

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